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COST AND CUSTOMER SERVICE ISSUES IN NAVY MEDICAL LOGISTICS

by

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The purpose of this research is to examine inventory management issues in today's Navy healthcare environment. The automated inventory systems and inventory processes used by Navy medical inventory managers limit their ability to control variable inventory costs and provide good customer service. This thesis examines two current approaches used by Navy medical material managers at several Navy Medical Treatment Facilities: the Medical Inventory Control System (MICS) and the Prime Vendor Program. Background and case study research obtained from the Naval Medical Center, Oakland are used for comparative analyses of these approaches with cost minimizing models and service level models. Research results indicate that although introduction of the Prime Vendor Program has been effective in addressing many of the cost and customer service problems associated with MICS, several inefficiencies still exist and explicit cost minimization is not specifically addressed with the Prime Vendor Program. It is recommended that the MICS be changed to allow Navy medical inventory managers to correct the cost and customer service inefficiencies noted in this research or that the MICS be replaced with an automated system that provides Navy medical inventory managers with the ability to optimally manage their inventories.

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COST AND CUSTOMER SERVICE ISSUES IN NAVY MEDICAL LOGISTICS

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ABSTRACT

The purpose of this research is to examine inventory management issues in today's Navy healthcare environment. The automated inventory systems and inventory processes used by Navy medical inventory managers limit their ability to control variable inventory costs and provide good customer service. This thesis examines two current approaches used by Navy medical material managers at several Navy Medical Treatment Facilities: the Medical Inventory Control System (MICS) and the Prime Vendor Program. Background and case study research obtained from the Naval Medical Center, Oakland are used for comparative analyses of these approaches with cost minimizing models and service level models. Research results indicate that although introduction of the Prime Vendor Program has been effective in addressing many of the cost and customer service problems associated with MICS, several inefficiencies still exist and explicit cost minimization is not specifically addressed with the Prime Vendor Program. It is recommended that the MICS be changed to allow Navy medical inventory managers to correct the cost and customer service inefficiencies noted in this research or that the MICS be replaced with an automated system that provides Navy medical inventory managers with the ability to optimally manage their inventories.

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I. INTRODUCTION

A. BACKGROUND

The cost of health care continues to escalate at an alarming rate. With anticipated further reductions in the defense budget, Navy hospital material managers are experiencing increasing pressure to reduce inventories of medical supplies and eliminate waste and excess. At the same time, material managers are being asked to ensure that medical supplies are available when they are needed so that health care providers can deliver quality care without rework or patient rescheduling. Since the demand for supplies is not experienced at a constant rate, some extra "safety" stock needs to be maintained in inventory to protect against not having what is needed for patient care. How much extra stock should be kept and how frequently stock should be ordered are decisions confronting every inventory manager. Definite costs are associated with holding the stock in inventory, ordering the stock, and an implied shortage cost exists when extra stock is held to prevent its not being available when it is needed. Thus, the inventory manager, when making decisions as to when to order stock and how much stock to order, is also making decisions, either purposely or implied, about the amount of defense funds being spent and the probability of being able to deliver material to the customer when required to do so.

B. RESEARCH OBJECTIVE

The intent of this research is to examine two current approaches used by today's Naval medical inventory managers; the Medical Inventory Control System (MICS) and the Prime Vendor Program.

In 1986 the Navy Medical Department developed, and implemented in many Navy Medical Treatment Facilities, a service unique inventory management system called the MICS. Since then, several versions of the MICS have been released. This thesis evaluates how the MICS performs relative to other inventory management models used in Navy wholesale and retail level inventory management in terms of balancing costs and responding to customer needs. Further, this research identifies the MICS shortcomings to the medical inventory manager and the possible impact of the MICS shortcomings.

The Prime Vendor Program was first implemented in Navy Medical Treatment Facilities in 1993. This thesis examines the Prime Vendor Program and evaluates the program as a possible response to customer service and cost containment shortcomings of the MICS.

The overall intent of this research is to offer recommendations to improve the ability of Navy medical inventory managers to balance inventory costs and meet custormer service requirements.

C. SCOPE

This research reviews current DoD practices regarding the measurement of customer service and the calculation of related inventory costs. The MICS information and decision-making criteria are reviewed. The performance of both are then compared using inventory data collected from the Naval Medical Center, Oakland. The Prime Vendor Program is next discussed. It is evaluated through a review of the effects of the Prime Vendor Program on inventory management after a ten-month implementation period at Naval Medical Center, Oakland.

D. ORGANIZATION OF THE THESIS

To provide background information about the definition of customer service from a probabilistic aspect, an in depth review of stock availability and inventory risk is introduced in Chapter II. How the inventory manager adjusts stock availability quantitatively to meet a given level of customer service is explained in detail in Chapter III. Chapter IV defines the variable costs associated with managing an inventory item. An explanation of how DoD calculates variable inventory costs are presented. In addition, the results of a Government contracted evaluation prepared by Synergy, Inc., is also provided. How DoD uses inventory costs to assist in managing inventory is illustrated in Chapter V by identifying two models used in wholesale and retail inventory management for other than Navy medicine; the Uniform Inventory Control Program (UICP) and the Variable Operating and Safety Level (VOSL). The MICS model is explained in Chapter VI and evaluated in Chapter VII using inventory data extracted from inventory status reports from the Naval Medical Center, Oakland. The Prime Vendor initiative is discussed in Chapter VIII. Its effects on inventory costs and customer service levels in Navy Medical Treatment Facilities is also discussed. Chapter IX presents a further discussion of the Prime Vendor concept in operation using specific data obtained from Naval Medical Center, Oakland. Finally, a summary of the research effort, conclusions drawn from it, and recommendations for changes are provided in Chapter X.

II. DEFINING CUSTOMER SERVICE

This is the era of focus on service to the customer in business practices. The Department of Defense has adopted this philosophy and has primarily proliferated the ideas through mandatory courses and inservice training in Total Quality Leadership (TQL). Navy Medical Treatment Facilities have embraced TQL, dedicating entire office staffs to oversee training in, for example, how to identify and communicate with your customers. The purpose of this chapter is to explain the importance of customer service in general and in the Department of Defense. This is achieved through a discussion of the elements of customer service.

A. IMPORTANCE OF CUSTOMER SERVICE

How well customers are served is a continually growing concern in both the private and public sector. Customers' goodwill and returning business are competed for by private firms by providing good customer service. To private sector firms better customer service can mean higher profits. Because the Department of Defense has a list of captive customers, competing for returning business is not necessarily a concern in DoD. But, better customer service can also mean cost minimization by reducing the amount of unneeded stock and reducing the amount of work and customer dissatisfaction associated with stockouts. In the framework of the Total Quality Leadership concept, DoD has made customer service an issue to be recognized by the military logistician in delivering supplies.

To the Navy Medical Logistician managing a warehouse in a Navy Medical Treatment Facility, Total Quality Management customer service means getting the right mix of medical

consumables to the wards and clinics at the right time for patient care. Serving customers well, at the least cost to DoD, is today's management goal for medical logistics.

B. ELEMENTS OF CUSTOMER SERVICE

The supply logistician's mission is to get the customer what he wants, where he wants it, when he needs it, at the best price. Customer service is the combined result of all of the logistician's activities. Processes used throughout the logistics system will ultimately affect the level of customer service offered. Decision variables and mathematical parameters used in inventory management systems models are usually designed to focus on a particular element of customer service. The choice of focus taken, however, leads to an implied overall level of customer service.

Lalonde and Zinzser researched the relative importance of various service elements to the customer. Dominant in the minds of 63% of the respondents in their study was the value of product availability [Ref. 5; p. 84]. In another study by Baritz and Zissman late delivery was the most important relative to poor customer service [Ref. 5; p. 84]. The authors noted that this factor is often a *result of poor stock availability* in the logistics system.

C. DEFINING STOCK AVAILABILITY

Stock availability is defined in the context of this research as the probability that a given stock item will be available to be distributed to the customer when a request for that item is received by the inventory manager. The probability that a stocked item is available is obviously related to the risk of being out of stock; that is,

Stock Availability = Probability that a requested item is in stock and available for customer use;

Risk of Stockout = (1 - stock availability).

Therefore, an inventory stock item that has a 90% stock availability carries a 10% chance, or risk, that the item will not be available for the customer when he requests that item.

For a continuous review inventory model, stockouts can only occur between the time a replenishment order is placed and is received; that is, during the procurement lead time after an order is placed. The Medical Inventory Control System (MICS) used in Navy Medical Treatment Facilities (MTF) is a continuous review model. An important aspect which typically is ignored is that between the time the replenishment order arrives and the inventory is again reduced to the reorder point, there is 100% stock availability. Thus, the real availability for a continuous review system is much higher than just that for the procurement lead time.

D. STOCK AVAILABILITY VERSUS FILL RATE

The term fill rate, a common measure of effectiveness in military medical inventory management at the MTF level, is often confused with the notion of stock availability. Where stock availability refers to the probability of being able to fill a request for a single stock item, the fill rate refers to the average rate at which all requisitions for stock can be filled from total inventory stock on-hand over a specified time period of, say, a year.

$$\text{fill rate} = 1 - \frac{\text{number of requisitions filled during a year}}{\text{number of requisitions received during a year}}$$

An inventory manager may be typically evaluated on his ability to fill requisitions from stock. He may be required, for example, to fill at least 95% of all requisitions submitted for the day, month or year. Fill rate is obviously related to stock availability in that an inventory manager will tend to have a lower fill rate if the probability of stock availability is low. This research focus

is on stock availability with the assertion that managing the *probability* that stock is available will result in the ability to meet fill rate goals at least cost.

E. CONCLUSION

Specifying stock availability and fill rate goals affect the nature and the use of the supplies and other organizational goals with respect to related costs. Managing particular stock items to a specified customer service level of stock availability or fill rate requires information about the customer requirements and aligning logistics planning to that information. Later chapters of this thesis cover in detail how wholesale and intermediate inventory managers address customer service requirements by factoring a risk term into reorder point calculations. No specific customer service level is applied in setting reorder point decisions at the Navy Medical Treatment Facility retail level. Based on the nature of the critical need of many medical supplies, the introduction of a risk or shortage term in calculating stocking objectives in retail inventory management would be a logical strategy. The next chapter presents a discussion of managing medical consumable stock to meet a given level of customer service.

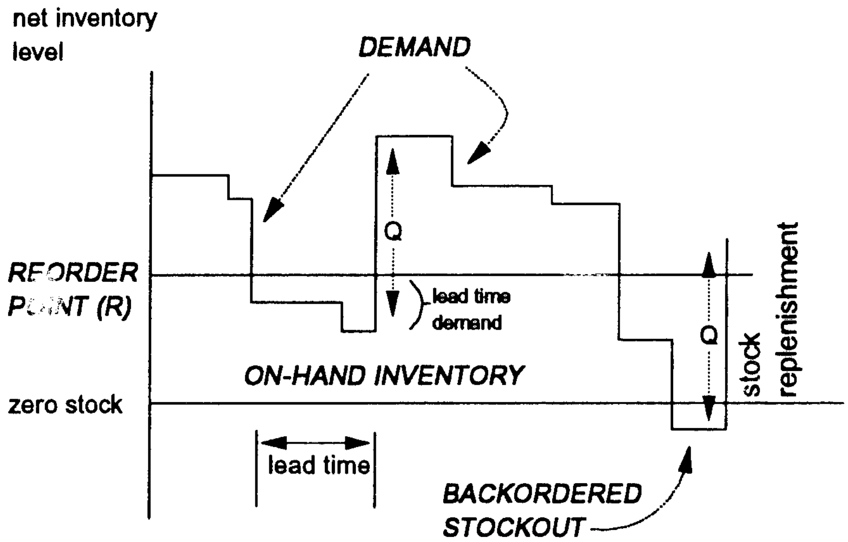
III. QUANTIFYING STOCK AVAILABLITY

Stock availability, or the probability that a given stock item will be available to be distributed to the customer when a request for that item is submitted to the inventory manager during the procurement lead time after an order is placed, has been defined in the context of this research as a critical element of customer service. The nature of demand for those items is therefore an important consideration. Once the nature of demand is determined, the inventory manager can manage stock to a specified level of customer service stock availability, yet minimize costs by maintaining the right amount of stock to meet anticipated demand requirements and by reordering stock at the right time. This chapter discusses how an inventory manager can compute a reorder point to meet the stock availability requirements for a given level of customer service. This discussion of inventory management considers only a consumable item inventory. Repairable parts inventories and provisioning requirements are specifically **not** covered in this discussion. Much of the discussion is applicable to any consumable item where demand is random; that is, the specific demand is not known ahead of time but its value can be modeled by a probability distribution. Medical consumable items are used as examples to exemplify the stock management environment at a Navy medical treatment facility.

A. NATURE OF DEMAND

The typical medical item's demand is assumed to be in steady state; that is, while demand is a random variable, its distribution mean and variance do not change over time. Some instances of seasonal items, (for example, cough syrup) can be found but they exceptions rather than the rule. A tendency may be to assume many items have a derived demand (for example, hip

Figure 3 -1. Continuous Review Inventory Control System



replacement or other surgical items that are purchased for a unique form of surgery). These items are not typically stocked in the medical warehouse. They are instead specifically requested for a planned use and are turned over directly to the customer upon receipt of the items from the vendor.

Item demand over a given time period will be assumed to be approximated by using a Normal probability density function. In practice, slight discrepancies from the theoretical properties associated with the Normal distribution may occur in some unique categories of medical consumable supplies. Variations such as these may require evaluation using a Poisson probability distribution and are not in the scope of this research.

B. STOCKOUTS AND REORDER POINTS

Figure 3-1 illustrates the notion of a stockout for a continuous review inventory management system. Stockouts occur when demand during lead time for an item exceeds the reorder point value. The reorder point (R) can be determined once the desired **probability of**

stock availability (or acceptable risk of stockout occurrence) is defined. When lead time demand is Normally distributed, the reorder point can be determined using the following formula;

$$R = D * L + z * \sigma_{DLT}$$

where;

D = mean demand rate, units per month;

L = average procurement lead time, months;

σ_{DLT} = standard deviation of lead time demand and;

z = Normal deviate.

If the desired level of stock availability is 95%, R is set to limit the stockout risk to 5% by using a value for z of 1.645.

Therefore,

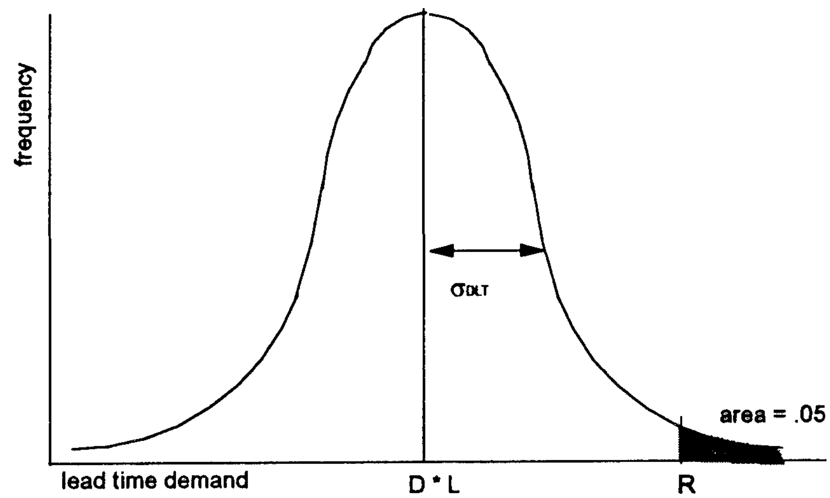
$$R = D * L + 1.645 * \sigma_{DLT}.$$

Note, the safety stock is the $z * \sigma_{DLT}$ term. Thus, for the 95% level,

$$\text{safety stock} = 1.645 * \sigma_{DLT}.$$

Figure 3-2 illustrates this concept for the Normal distribution having a mean of D*L and a standard deviation σ_{DLT}.

Figure 3-2. Setting the Reorder Point to meet a Stock Availability Probability of 95%



If the desired level of stock availability is 99%, R is set to limit the stockout risk to 1% by using a value for z of 2.325.

Therefore,

$$R = D * L + 2.325 * \sigma_{DLT}$$

and the safety stock is now;

$$\text{safety stock} = 2.325 * \sigma_{DLT}.$$

Table 3-1 lists the values for z used to determine the reorder point for typical desired stock availability rates.

Table 3-1. Normal Deviate (z) Values for Various Levels of Stock Availability

Probability of Stock Availability	*Value of z*
80%	.845
85%	1.035
90%	1.285
95%	1.645
99%	2.325

C. CONCLUSION

This chapter discussed how an inventory manager can compute a reorder point to meet the stock availability requirements for a given level of customer service when demand during procurement lead time is Normally distributed. The next chapter discusses costs associated with inventory management that may be reduced through efficient and effective inventory management.

IV. DEFINING COSTS IN MAINTAINING INVENTORY

The purpose of this chapter is to introduce the variable costs associated with acquiring and maintaining a medical consumable item in inventory. The costs discussed are similar to those associated with maintaining any inventory of consumable items. These costs include ordering, holding and shortage costs.

A. ORDERING COSTS

1. Background

Ordering costs reflect the expenses incurred to perform the tasks of:

* requirements determination

* requisition preparation and recording

* receipt processing

* stowage of material

Ordering costs are a function of the procedures used at the requisitioning and issuing activities to complete the above tasks. This implies that ordering costs will depend upon the level of automation of the activity and will depend also on the handling requirements for different types of material specific to the activity. To calculate ordering costs, data can be collected for these major cost categories, labor and ADP support.

2. Determining order costs

a. DoD

The Military Departments and the Defense Supply Agency are directed by the Chief of Naval Operations (CNO) to minimize the total variable cost relative to ordering and

holding inventory at Inventory Control Points and their stock points, subject to a constraint on time-weighted, essentiality-weighted requisitions short [Ref. 38; p.2]. DoD Instruction 4140.39 implements the CNO directive by defining ordering and holding costs and establishing how these costs are to be determined for centrally procured items at Inventory Control Points. Variable cost to order are defined as [Ref. 7; Encl 3]:

> Those costs associated with the determination of requirements, processing of a purchase request, and subsequent contract action through receipt of the order in to the Inventory Control Point system that will vary significantly in relation to the number of orders processed.

Order costs are considered "fixed" if they would remain constant should 50% of the workload be eliminated.

DoD Instruction 4140.39 accounts for the differences in the alternative ways of ordering material within the wholesale inventory management environment by recommending that different cost calculations be made in each organization for groups of items having similar acquisition strategies. Three procurements types are listed:

*Items likely to be procured using small purchase techniques (contracts of $2,500 or less);

*Purchases where a call-type contract is employed; and,

*Purchases where the contract value is likely to be greater than $2,500 and where negotiated, advertised or other procurement methods are employed.

To develop an order cost, data should be collected for each functional element of procurement. The functional elements are as follows:

*Direct Labor/Associated ADP Costs per item procured. These data are relative to processing purchase requests, contract solicitation and award, and receipt of stock item/invoice processing. The direct labor costs can be computed int the same way as those described below in subsection b.

*Labor Benefit Costs. Costs are computed at 8% of direct labor cost and relate to costs associated with personnel benefits, life insurance, retirement and disability.

*Indirect Labor/Support costs not included in Direct Labor or Labor Benefit Costs. Costs in this category are primarily related to communication costs, mail and personnel support (Civilian Personnel Office).

b. Synergy Inc.

Synergy, Inc., has provided a general approach for the Defense Logistics Agency (DLA) to develop order cost figures [Ref 22; p. 49]. Their suggestion is to calculate direct labor costs in the ordering process based on the use of performance standards as follows:

1. Identify time standards related to labor tasks, defined by the organization, based upon standard processing times;

2. Identify the work center that will perform the task;

3. Use the grade structure of the work center to assign an average wage value for the work to be performed;

4. Multiply the average wage value by the time standard determined to complete the ordering task, obtaining the work center cost for the task; and,

5. Multiply the work center cost by the organization determined probability that the task will occur.

Synergy also accounts for the differences in the alternative ways of ordering material within the wholesale inventory management environment by recommending that different cost calculations be made for groups of items having similar acquisition strategies.

An example of the ordering cost derived for the process of item manager review for a recommended buy is provided below for a medical item [Ref. 22; p. 57];

Process: **Medical Item Manager Review**

Average GS level: **10**

hours to complete process	**average wage**	**process order cost**
.4710	**$14.26**	**$6.72**

The Synergy study limits its analysis to wholesale level inventory management but there is a viable application of this process to the calculation of ordering costs in retail acquisition in a military treatment facility. For example, there are different process standards and therefore would be different composite standard times required for the various acquisition strategies used at the retail level in each military treatment facility. At the retail level, both the task of determining which acquisition strategy to follow and the processes associated with procurement are different yet similar in complexity to other medical treatment facilities and the wholesale inventory management level. For example, a military treatment facility bases its acquisition strategy on an item's management code. This code, called the Acquisition Advice code (AAC), classifies a stock item as to whether the item is stocked at the wholesale level (AAC D), can be ordered from the manufacturer by Electronic Data Interchange (EDI) (AAC H), or whether the item must be

procured by local purchase procedures (AAC L). Some medical treatment facilities have contracting offices in the facility to procure the AAC L items, others do not and must use the base contracting office. Each procedure has process time elements unique to that facility.

B. HOLDING COSTS

Holding costs are the costs of having inventories of material on hand to distribute to meet customer demand. The costs include costs associated with keeping capital funds invested in inventory, cost of losses for material that is outdated or its shelf life has expired and it must be disposed of, cost of losses due to pilferage and damage and the costs of physical storage.

The DoD Instruction 4140.39 [Ref. 7; Encl 4] establishes cost values for the components of holding cost to be used by Military Departments to determine the annual variable cost to hold for DoD facilities carrying an inventory of a certain item. More recently, The Office of the Assistant Secretary of Defense (Production and Logistics) published the same values in the DoD Material Management Regulation (DODINST 4140.1-R) [Ref. 10; p. 87]. The values are listed in Table 4-1.

Table 4-1. Holding Cost Rate

Investment charge	10%
Forecast error and obsolescence costs	variable
Inventory losses	variable (5% maximum)
Storage costs	variable (1% maximum)

The sum of the parameters in Table 4-1 defines the holding cost rate per dollar invested in inventory. This rate times the unit cost of the material gives the cost to hold one unit of the material for one year:

Cost to hold one unit = Holding cost rate x Unit cost of material.

A discussion of the Holding cost parameters, as defined, follows.

1. Investment Charge

The investment charge is the cost of capital over time or the "time value of money". It is the opportunity cost associated with buying inventory today and thus losing the opportunity to invest the dollars in something else. Per DoD Instruction 7041.3, *Economic Analysis and Program Evaluation for Resource Management,* the 10% rate is said to be;

> ...the weighted average opportunity cost of private spending that is reduced as a result of taking money out of the private sector...this policy is based on the premise that no public investment should be undertaken without explicitly considering the alternative use of the funds which it absorbs or displaces.

Synergy Inc., also addressed the cost to hold methodology, recommending that the average rate of long-term government securities be used as the basis for investment charge. This is also the rate used for long-term borrowing by the federal government. This rate is reflected in the yield of long-term treasury bonds and is therefore easily accessible.

Treasury bond yield values are circulated periodically by the Office of Management and Budget (OMB) for the specific purpose of cost-benefit and economic analysis in Federal Programs. The OMB rate, effective through February 1996, for long-term (30 year) treasury bonds is 8.1% [Ref. 39]. If Synergy's recommendations regarding the appropriate rate for

investment charge used in holding cost calculations is reasonable, then the 10% figure used by DoD overstates the current cost of capital.

2. Forecast error and obsolescence costs.

The cost of losses due to obsolescence is addressed DoD Instruction 4140.39:

> Losses due to obsolescence, for the purpose of this Instruction, are intended to include losses of materiel due to all causes that render the on-hand material superfluous to need. Thus, this element will include losses due to technological obsolescence, over-forecasting of requirements, deterioration beyond the point of use and other causes.

The purpose of including the value of obsolete or unneeded stock into an inventory decision is that the higher this cost factor is the more effort the inventory manager should expend to reduce both the order quantity and reorder point.

DLA obsolescence rates, except medical, vary between 6% and 8%. The Army and Air Force both use an obsolescence rate between 2% to 6%. [Ref. 22; p. 149]. The current rate used by the Navy for obsolescence is 10% for both repairables and consumables. This rate was last updated in 1979 by the Navy. [Ref. 30; p. 2-4]. Synergy suggests that the Navy lower its rate to be more in line with DLA, the Army or the Air Force.

DLA uses even lower obsolescence rates for medical supplies (as low as 1%). DLA suggests that medical items require careful management and therefore the typical short shelf life and high turnover reduces the likelihood of material becoming outdated due to obsolescence [Ref. 22; p. 149].

3. Inventory Losses

DoD Instruction 4140.39 specifies that losses due to pilferage, shrinkage and inventory adjustments are to be included in inventory holding cost. DLA and the Air Force assume this rate to be zero. The Navy assumes the rate to be zero for repairables and 2% for consumables. Synergy suggests that inventory loss is a non-issue due to DoD security requirements and suggests 0% be applied.

In the medical environment, inventory that is reported as a loss is often only temporarily misplaced. This may happen as a result of limited storage space. Also, quick turnover of supplies may result in improper receiving and issuing procedures and files maintenance. As a consequence, material may seem to be lost but is really not. Inventories that are adjusted due to loss may often at a later date be adjusted again for a gain when the item(s) is found. [Ref. 4]. Thus, a zero loss rate seems appropriate.

4. Storage Costs

DoD Instruction 4140.39 defines the cost of storage [Ref. 7; Enc. 4],

> The cost of storing the inventory itself includes: care of material in storage, warehousing costs, cost of physical inventory operations, preservation and packaging, training of storage personnel, cost of warehousing equipment and pro-rated base services and overhead costs. The sum of these annual costs divided by total average on-hand inventory, all on-hand assets as opposed to applicable assets, gives the out-of-pocket storage cost rate. The facilities cost rate is added to the above to give the total storage cost rate.

From the DoD Instruction, DLA and the Navy have adopted a 1% storage rate. Studies done by the military have since indicated that the 1% estimate seems accurate and have therefore not proposed a change. Synergy examined DLA cost accounts for storage and compiled an

estimated storage rates between .9% and 1.3%. Synergy concluded that the use of 1% by DLA was reasonable based on the cost methodology utilized. [Ref. 30; p. 4-19].

No specific mention was made by Synergy regarding unique storage requirements for controlled inventory items. Of particular concern and within the scope of this research are medical pharmaceuticals. For example, narcotics require very specific handling and storage. In a Navy Medical Treatment Facility, only specific personnel can be assigned the tasks of warehousing, rewarehousing, and physical inventory of narcotics. Further, certain temperature conditions and other specific storage facilities, such as a secure vault, are required to be maintained to store the narcotic items. Under these circumstances, storage costs should be expected to be greater than 1%.

5. Conclusion

To summarize, the values that are commonly used for the components of the holding cost rate (23%) for consumable items by the Navy are shown in Table 4-2.

Table 4-2. Navy Consumable Item Holding Cost Rate

Component	Value
Cost of Interest	10%
Obsolescence	12%
Losses	2%
Storage Cost	1%
Total	23%

Navy Medical Treatment Facilities' inventory managers stock unique consumable material which may tend to impact the applicability of the value of the established standard holding cost rate parameters. For example, the relatively short shelf life of the majority of material suggest higher turnover rates and therefore possibly a lower than the 10% obsolescence rate. Additionally, many medical items have storage and handling requirements that suggest a higher storage cost rate than 1%. However, both of these holding cost rate components are those currently recognized as applicable to Navy Medical inventories and will therefore be used for later calculations in the scope of this research.

C. SHORTAGE COSTS

The DoD Instruction 4140.39 and more recently the Material Management Regulation, January 1993, [Ref. 10] do not provide guidance in estimating shortage costs for either wholesale or consumer level inventories. Shortage cost factors are typically used as a "control knob" in calculating stocking objectives, especially reorder points, to allow inventory managers to maintain a certain level of customer service. Raising a reorder point will reduce the risk of stockout; lowering the reorder point will increase stockout risk. For example, the Navy wholesale model includes a backorders cost term in its expected total annual cost equation. It then adjusts the shortage cost "knob" to meet the inventory goal of an annual requisition fill rate of 85%. Thus, on the average, no more than 15% of the requisitions for an item submitted during a year are not expected to be immediately filled.

D. CONCLUSION

This chapter provides information regarding the various variable costs associated with managing a consumable item inventory and how those costs can be calculated or estimated.

Ordering costs are a function of the set of procedures used to perform the tasks of stock requisitioning, receiving, stowage and issue. DoD and Synergy Inc. offer a framework with which to calculate ordering costs in inventory management.

Holding cost is the cost associated with holding stock in inventory for later issue or sale. This cost can represent a significant opportunity cost of capital funds and the cost associated with loss (expired and/or pilfered) inventory. When holding costs are factored into stock levels, the Navy commonly uses 23% as its holding cost rate for consumable items. While this rate may not be as accurate in the framework of managing medical material as it would be with other consumable material, it is considered adequate by this author for the purposes of this research.

Shortage cost estimation is not specifically addressed by DoD or Navy instructions. However, shortage cost terms are implicitly included in some inventory management models by setting specified customer service level goals. Further discussion of the use of shortage cost terms in DoD inventory models is presented in the next chapter.

As will be discussed further in Chapters VI and VII, Navy Medical does not currently use any ordering, holding or shortage costs in inventory management at the retail level.

V. MANAGING STOCK TO MINIMIZE VARIABLE COSTS

This research focused initially on managing inventory of items by maximizing customer service without considering related variable costs. Various inventory costs were then introduced in Chapter IV. The purpose of this chapter is to discuss some methods of inventory management used in DoD which incorporate these costs and customer service levels into an expected total annual costs equation which can be used to determine an "optimal" reorder point and order quantity.

Two models are reviewed in this chapter. The first is the Navy's Uniform Inventory Control Program (UICP) used for managing wholesale consumable items. The second is the Navy's Variable Operating and Safety Level (VOSL) model. That model is used as part of the Uniform Automated Data Processing System (UADPS-U2) by Fleet and Industrial Support Centers (FISC) to set inventory requirements for demand-based items at the next echelon below wholesale. Both models provide background for later analysis of the Navy Medical Inventory Control System (MICS) and its ability to incorporate expected costs into the process of determining optimal order quantities.

A. UNIFORM INVENTORY CONTROL PROGRAM (UICP) [Ref. 9; Chapter 3, encl A]

The UICP model, assumptions, variable definitions and cost terms are shown in Table 5-1. The objectives of the UICP model are to determine optimal order quantities and reorder points for each item such that the total annual variable order and holding costs are minimized, subject to

Table 5-1. <u>The UICP Model</u>

$$TVC = \sum(4D/Q)A \;+\; \sum(R + Q/2 - DL + B)\,IC \;+\; \lambda E\sum(B/S)$$

(expected ordering cost) *(expected holding cost)* *(shortage cost term)*

TVC = total annual variable costs over a class of items
D = expected quarterly demand
Q = order quantity
A = administrative cost of placing an order
R = reorder level
L = procurement lead time
B = expected number of units of stock backordered at any random point in time
I = inventory holding cost rate
C = unit cost
S = expected number of units per requisition
λ = shortage cost of one requisition backordered for one year
E = military essentiality
4D/Q = expected number of procurement orders per year
R+(Q/2)-DL+B = expected number of units of stock on hand at any random point in time
IC = holding cost per unit of stock per year
B/S = expected number of requisitions backordered at any random point in time

The UICP model assumes:

*a consumable inventory which is multi-item and is managed using a continuous review procedure; (note that the subscripts reflecting individual items have been suppressed but are implied by the summation sign),

*a steady state environment; that is, quarterly demand has a known probability distribution and a constant mean and variance;

*an exact lot size (Q) is ordered when the inventory position is at the reorder point;

*the time-weighted cost of a backorder can be accurately quantified;

*the relative military essentiality of an item can be quantified; and,

*the probability distribution is Normal, Poisson or Negative Binomial.

a constraint comprised of time-weighted, essentiality-weighted, requisitions short. When the constraint is added to the costs to order and hold, the resulting Lagrangian function is the Total Variable Cost (TVC) equation shown in Table 5-1. The Lagrange multiplier λ can therefore be viewed as a shortage cost. Thus, the holding, ordering and shortage costs are balanced against one another in determining optimal order quantities and reorder points.

1. Demand and Lead Time Forecasting

A single exponential smoothing model is used to forecast both the mean quarterly demand and mean procurement lead time. This method calculates a forecasted value for the next period based on a geometrically weighted average of historical data that places more weight on more recent data. Demand filters prevent the incorporation of extreme values and trend detectors allow for change to the exponential smoothing constant to a higher value.

2. Order Quantity and Reorder Point Optimization

Taking the partial first derivatives of TVC with respect to Q and R and setting them equal to zero results in formulas for optimal Q and R which are functions of each other. Thus, an iterative solution procedure is required. However, the Navy did not have the computer capability to do that when the model was implemented in the early 1970's. Therefore, the Navy set Q at the economic order quantity and, through an elaborate algebraic argument, derived a risk formula for determining the reorder point which is independent of Q. The result is the smallest Q and the largest R and hence smaller buys but better safety levels and thus higher fill rates. The UICP system uses an 85% fill rate as the customer service performance goal. The result is a reorder point which ensures that annual inventory fill rate will meet the fill rate goal and an order quantity which minimizes total annual variable costs to order and to hold.

B. VARIABLE OPERATING AND SAFETY LEVEL (VOSL)

The same general theory used in the UICP model applies to the VOSL model which is used at the intermediate retail level. Each FISC uses VOSL for the purpose of procuring and managing DLA items. The objective of the VOSL model is the same as the UICP wholesale model; to minimize the expected annual total variable inventory management costs. However, VOSL does not directly use the EOQ formula for Q because it was designed many years ago to be run on computers which could not calculate square roots. As a consequence, certain parameters which were needed to determine Q and R were provided by the Navy's Fleet Material Support Office (FMSO) to help with the overall management of all a FISC's 9-Cog (medical) items.

1. Order Quantity

VOSL balances holding and ordering costs by close management of the operating levels for categories of stock items based on value. Once a year FMSO segments a FISC's carried stock into categories called VADCATS, based on the Value of Annual Demand (VAD). Associated with each VADCAT is an operating level factor. This factor is used to calculate the "economic order quantity". The VADCAT range value may vary among FISC's but there are always ten categories having the operating level factors shown below: [Ref. 9; p. 4-30]

VADCAT	VAD RANGE	OPERATING LEVEL FACTOR (OLF)
A	$12,235.04 +	1
B	$7,465.17 - 12,235.03	1.5
C	$4,442.54 - 7,465.16	2
D	$2,949.50 - 4,442.53	2.5
E	$1,866.29 - 2,949.49	3
F	$1,110.63 - 1,866.28	4
G	$737.38 - 1,110.62	5
H	$466.57 - 737.37	6
I	$238.05 - 466.56	8
J	$ .01 - 238.04	12

The product of the OLF and the average monthly demand gives the "economic order quantity". It is called the operating level (OL). The formula is:

$$OL = (\text{AVERAGE QUARTERLY DEMAND}/3) * OLF.$$

Items with high unit prices or a large annual demand will be placed into, for example, VADCAT A. A VADCAT A item would have an order quantity equal to one month's worth of demand. At the other end of the spectrum, a VADCAT J item has a high OLF due to a low unit price and its order quantity would be equal to its annual demand. The VADCAT approach prevents the item manager from having too many dollars invested in high value items.

2. Reorder Point

As in the UICP model, the amount of safety stock is variable and is calculated by the system automatically as a function of quarterly demand variance, mean lead time variance (assumed to be zero; i.e., L has a known constant value), the unit price of the item and a safety level factor determined by FMSO. The steps used to calculate the reorder point (RP) in VOSL are summarized below beginning with the risk equation.

The risk equation for VOSL is;

$$\text{RISK} = \lambda * OL * UP/AF$$

where:

λ = safety level factor developed by FMSO for the FISC; this factor is used to distribute the total dollars allocated for safety level where safety levels are varied by item to maximize requisition effectiveness within the overall investment constraint.; [Ref. 31; p.145]

AF = annual requisition frequency;

OL = operating level in units (the "economic" order quantity);

UP = unit price.

Risk is constrained by:

$$.01 \leq \text{RISK} \leq .5$$

If calculated risk falls outside these limits, the nearest limit is used. The resulting constrained RISK value is then used to determine the protection level factor (T) which is really the standard Normal deviate associated with the normal probability distribution assumed for lead time demand. The safety level (SL) is then calculated from:

$$SL = T * .7217 * MAD * \sqrt{FLT};$$

where;

T = Protection Level Factor;

MAD = Mean Absolute Deviation of quarterly demand;

FLT = average Forecasted Lead Time in months;

.7217 = Conversion factor which converts quarterly demand variance from the MAD into the quarterly standard deviation and the lead time into quarters.

After the safety level is computed, the reorder point (RP) can be computed;

$$RP = SL + LTD;$$

where;

SL = Safety Level;

LTD = Mean Lead Time Demand = D * FLT; and

D = Forecasted monthly demand.

3. Demand and Lead Time Forecasting

Single exponential smoothing models are used to forecast quarterly demand and procurement lead time. Also, the VOSL model incorporates a demand filter procedure which flags abnormally high or low demand as it compares to the forecasted value. This allows for identifying spurious data or detecting major demand changes. The lead time is constrained to be no more than 120 days and no less than 10 days in CONUS.

C. CONCLUSION

The UICP model provides the inventory manager with the benefit of both cost consideration and customer service level control. Stock parameters are established using the UICP algorithm which minimizes costs of inventory management while meeting an explicit customer service goal. The VOSL model incorporates cost and customer service level control also. This model minimizes the expected annual variable costs to order and hold by sorting items into VAD categories and then computing operating levels and quantities. The reorder point is determined by computing the safety levels which minimize the expected costs to hold and have backorders. But, again, the shortage cost parameter is selected to insure a certain customer service level. The next chapter discusses the Navy medical inventory management system called the Medical Inventory Control System (MICS). As will be shown, many of the elements and optimizations presented in the discussions of the UICP and VOSL models are not found in the MICS system.

VI. THE MEDICAL INVENTORY CONTROL SYSTEM (MICS)

The purpose of this chapter is to discuss the Navy's Medical Inventory Control System (MICS) which is the automated system used both in CONUS and out CONUS to manage Navy medical consumables in Navy Medical Treatment Facilities. MICS system management and proliferation is coordinated by the National Naval Medical Information Management Center located in Bethesda, Maryland.

A. INVENTORY SYSTEM OVERVIEW

Medical consumable inventories using MICS are funded with DoD's revolving fund called the Defense Business Operating Fund (DBOF). The Navy Ships Parts Control Center (SPCC) is the fund administrator for Navy Retail inventory systems. Semiannual stratification reports are sent to SPCC from the facilities using MICS. The inventories are funded by SPCC quarterly based on the total sales achieved by each site. The higher the sales, the more funding is allocated to a particular medical inventory.

MICS managed inventories are primarily consumer level or retail inventories. The purpose of the inventories is to support patient care within the same hospital, a tenant command or outlying medical clinic. The supplies are held in inventory until purchased by the hospital, clinics, or tenant commands, with OM&N funds. Other hospitals within DoD and some Navy ships which carry some medical supplies may, in an emergency situation, request a one-time supply distribution from a hospital's MICS managed inventory. This form of distribution indicates that MICS managed inventories from time to time act as an intermediate inventory as well as a retail inventory.

Supplies are sold and distributed from the medical inventory within a Navy Medical Treatment Facility or its outlying clinics in response to an internal requisition form. This form can be a local form or DoD form (for example, a DD1149). Supplies distributed to tenant commands require submission of form NAVCOMPT 2276. Each of these requisition forms indicate to the inventory manager a description of the items required, the number of the units of the items required and which end user account is to be charged. Requests submitted for material from federal stock usually contain only one line item per form. The inventory manager will usually arrange for delivery of the items or customer pickup and see that the appropriate end user's OM&N OPTAR is debited for the cost of the items requested.

A typical MICS inventory will consist of consumable stock items to support day-to-day patient care within the treatment facility, clinics and tenant commands and a partial allowance list called Pre-positioned War Reserve Material (PWRM). Other than PWRM, no allowance list or required list of consumable stock items for any of the Navy Medical Treatment Facilities exists. Therefore the MICS managed inventory is a result of "what sells" to the areas it supports.

The consumable inventory is usually a mixture of stock items acquired from various sources and through different procurement methods. The procurement method is defined by the Acquisition Advice Code assigned to an item. There are three dominant ones. These include Acquisition Advice Code D (ACC D) items which are available from the DoD wholesale level, Acquisition Advice Code L (ACC L) items which are only available through local purchase procedures and Acquisition Advice Code H (ACC H)

items which are available through electronic order directly with the manufacturers. ACC D items are items in the Federal Supply System that are stocked as wholesale inventories at the DLA Depots and managed by the Inventory Control Points (ICP). A MILSTRIP requisition is submitted electronically through the MICS system to place an order for an ACC D item. When a MICS inventory needs replenishment of an ACC L item, the inventory manager will submit a procurement requisition to the contracting office for the hospital. The contracting office purchasing agents will use DoD small purchase contracting procedures to purchase the item requested and arrange for delivery to the MICS warehouse by the required delivery date. ACC H items are those purchased by placing orders electronically directly to the manufacturer through MICS by using either of the DoD Standard Automated Material Management System (SAMMS) programs; Procurement Electronic Data Exchange (SPEDE) or Electronic Data Interchange (EDI).

The inventory includes a wide range of different types of items. A typical mixture of warehouse items will include both general administrative forms and more specialized medical /surgical items. Additions and deletions to inventory usually follow changes in medical technology or changes by doctors and nurses regarding item preference . The range of the inventory is therefore typically discretionary. There are some circumstances where an item has such a low demand that it does not really require automated continuous review but is carried in inventory simply for storage convenience due to its large, bulky size.

B. MICS VERSION 4.1

MICS software provides material managers with a continuous review of the stock items in inventory. The software is written in the third generation language DATABUS and operates in a UNIX environment on AT&T 3B2 terminals. Several versions of the software have been released since the program was first written in 1986. The current release is Version 4.1. At the time of this research 17 Navy medical treatment sites utilize the MICS system for inventory management. Two additional sites have been scheduled to receive MICS in Fiscal Year 1995 [Ref. 2]. This section provides an overview of the latest version of the Medical Inventory Control System software.

1. Demand and Lead Time Forecasting

The MICS software uses an historical projection method for forecasting demand using a simple moving average. The demand forecast is used by the MICS system to project expected stock requirements. Demand variance is not forecasted.

The forecast is updated at the end of each month. A premise of this method of forecasting is that future demand patterns will, for the most part, replicate the past. A further premise is that strong trend and seasonal variations in the time series do not exist. If both premises are correct this method of forecasting can be effective. If the premises are incorrect, then the forecasting method will present a lag in adapting, in particular, to new trends in demand information. This could create a possible stockout or excess inventory situation depending on the nature of the trend.

The MICS software does not attempt to forecast the procurement lead time. Older versions of the MICS software assume that lead time is fixed at one month

because orders from DLA have typically had an order and ship time of one month. With the new version of the software the inventory manager is required to estimate the lead time for each line item based on his or her experience with the source of supply. For example, an Acquisition Advice Code D line item that would be received by an in CONUS Medical Treatment Facility from an in CONUS DLA Depot may still be set at one month. However, an inventory manager may use a shorter lead time for an Acquisition Advice Code H line item that is obtained from Electronic Data Interchange (EDI) methods. Acquisition Advice Code L (open purchase) items that must be forwarded to a contracting office for procurement use the Uniform Material Movement and Issue Priority System (UMMIPS) with an assigned priority of 3, 6, or 13 and the associated standard number of days when calculating lead time. [Ref 10; p. 5-18] The priority selected would be based on the contracting office guidelines and urgency of the requirement. For example, a recurring demand item would normally be replenished using a purchase request with a priority 13 assigned. The item manager would expect delivery of the item 30 to 45 days from the date of the requisition. If demand unexpectedly increased such that a stockout may occur before the expected delivery time frame associated with a priority 13, then a higher priority is requested by the item manager. The contracting office will set aside routine orders to process urgent medical requirements with a priority assignment of 3 (1-3 days) or priority 6 (4-14 days).

No formal standard procedure is used by or required of the MICS inventory manager to track procurement lead times. Therefore the guidelines for selecting lead times in inventory management at a Navy Medical Treatment Facility are vague.

2. Inventory Position and Reorder Point

The classic definition of inventory position (IP) in inventory management is the quantity which is equal to the number of units on-hand plus the number of units currently on-order minus the units promised to customers or "backorders". Unfortunately, the MICS software does not track backorders. A requisition is treated as a "fill or kill". If a requisition is submitted for an item that is not in stock then the inventory manager issues a not in stock (NIS) reply to the customer for that item. If the item is critically needed, the inventory manager will attempt to obtain the item quickly through, for example, purchasing from a different supplier or requesting an express shipment. If the item is not critical, the inventory manager may request that the customer resubmit his requisition at a later date. In each case, however, the request is not entered into the MICS system to be counted as a backorder or to be used in forecasting future demand. A result of losing this demand information is additional stockouts.

The MICS system's current inventory position therefore includes only the number of units on-hand, called the ready for issue (RFI), plus the number of units on order with the supplier. When that inventory position meets or drops below the reorder point, based on the inventory position, the MICS system indicates to the inventory manager that it is time to reorder a quantity, Q.

3. Computation of the Reorder Quantity (Q)

The reorder quantity Q is determined by the facilities using MICS by calculating the amount of stock needed to bring inventory back up to the requisitioning objective or high limit. Older versions of the MICS system had a fixed Q set equal to

three months of expected demand for all line items because the requisitioning objective and reorder point, or low limit, were coded into the software as five months and two months of stock, respectively. Because the National Naval Medical Information Center (NNMIC) recognized that a general desire of medical treatment facilities was to drop inventory levels, MICS Version 4.1 allows a reduction in the value of Q for all line items below the earlier three-month standard. The inventory manager is now allowed to accept the value of Q that is suggested by the MICS system or vary the value of Q for individual line items up or down as deemed appropriate.

4. Computation of the Reorder Point (Low Level)

The reorder point is also known to the MICS inventory manager as the low level. Historically, MICS has used a reorder point equal to two months of expected demand [Ref. 18)]. However, Version 4.1 of MICS allows inventory managers to set the reorder point as desired for individual line items.

The computation of the reorder point involves first determining the reorder point multiplier. Its value is determined according to the following formula:

Low Level Multiplier (LLM) = Safety Level + Order & Ship Time,

where the units of safety level and order and ship time are in months. The product of the reorder multiplier and the forecasted average monthly demand provides the reorder point value. For example, suppose that,

safety level	1 month
order & ship time	1 month
forecasted average monthly demand	10 units/month.

Then

$$LLM = 1 \text{ month} + 1 \text{ month} = 2 \text{ months},$$

and the reorder point is equal to 20 (2 months * 10 units/month).

The inventory manager is able to vary the amount of material held as safety stock. How the safety level is specifically determined by the item managers in Navy Medical Treatment Facilities is unclear. Levels reviewed in the scope of this research ranged from one month to two months and were based upon item manager judgment regarding the stability of demand and order and ship time [Ref. 4]. The MICS software does not calculate or suggest an optimal safety level.

5. Computation of the Requisitioning Objective (High Level)

The requisitioning objective is the term given by MICS to the highest level of inventory position. This is the sum of the reorder point and the order quantity. The MICS computation of the requisitioning objective multiplier is: [Ref 19]

$$\textit{High Level Multiplier (HLM)} = (LLM) + (MQ)$$

where LLM was the multiplier used to determine the reorder point and MQ was the multiplier used to determine the order quantity. HLM is calculated in terms of months of demand since LLM and MQ are in those units.

Suppose for the previous example that LLM = 2 months and MQ = 2 months, then,

$$HLM = 2 \text{ months} + 2 \text{ months} = 4 \text{ months}.$$

The requisitioning objective is then 40 (4 months x 10 units/month).

At any time during the month or quarter an inventory manager may manually change the value of any of three multipliers to alter the stocking objectives. The inventory manager is not allowed to change the demand forecast. System recalculations will occur automatically after the changes have been made.

6. Shelf Life

MICS software does not have any provision for tracking the shelf life of a line item. This feature would be useful in reducing the amount of expired material if the software, for example, were able to provide material release orders by stock item lot number based on shelf life.

7. Retention Limit and Excess Supply

The retention limit is the maximum supply allowed to be held in inventory. SPCC has set the retention limit for ACC D, 9L cog material at the retail level as equal to the requisitioning objective (in months) plus 24 months. The purpose of the retention limit is to place a limit as to the amount of material an item manger can order above the requisitioning objective when he/she, for example, takes advantage of lot size discounts or orders extra due to unusual circumstances causing a long lead time in order and ship time.

Excess material is the amount of material on hand that is over and above the retention limit. [Ref. 19, 20, 21] MICS provides a report of excess material to the inventory manager. An inventory manager is then required to take action to eliminate this excess supply by either returning the material for credit or forwarding the material to the local office responsible for defense material reutilization, the Defense Reutilization and Marketing Office (DRMO). Material can be determined to be in excess due to

fluctuations of demand, neglect in reviewing stock records, discontinued programs or changes in support responsibilities. In the latter two cases, holding unnecessary excess material may reduce the level of funding the facility receives for the DBOF process.

8. War Reserve Material

Navy medical treatment facilities are required to stock prepositioned war reserve material (PWRM) for contingency purposes. The amount of stock to be carried for each line item is specific to the facility based upon the facility's designated wartime position and mission. Inventory managers are required to insure this contingency stock is added to the stock levels that have been discussed above. [Ref. 19] The actual stock should be rotated through the inventory so that it does not become obsolete. PWRM requirements increase the total level of stock held in inventory but do not affect the inventory manager's determination of safety and operating levels or retention limits.

C. COSTING IN THE MICS SOFTWARE

1. Unit Price Tracking

The MICS system software maintains unit price data. For all Acquisition Advice Code D and Acquisition Advice Code H items, the unit price maintained is the current price listed by DLA for that line item. The system is updated when DLA reports standard price changes and sends a monthly tape of the price changes to each stock point. Acquisition Advice Code L items maintain a unit price that is a computed moving average of the last five quarters of purchase price data.

A surcharge is added to the unit price for AAC D and H items by DLA as a cost recovery administration charge. The price paid for AAC D and H items by the MTF is

the unit price plus the surcharge. No additional surcharge is passed on to the end use customer. AAC L items are purchased from the vendor by the unit price. A surcharge is added to the item upon receipt. The end use customer pays the unit price plus the surcharge for AAC L items. The combined figure of the unit price plus the surcharge for each line item is found on-line and in the stock status report. The surcharges listed in MICS for Fiscal Year 1994 were as follows:

Acquisition Advice Code D	
Medical /Surgical	**26.70%**
Pharmacy	**14.20%**
Acquisition Advice Code L	**7.00%**
Acquisition Advice Code H	
EDI	**5.00%**
SPEDE	**5.90%**

2. Holding Costs

As discussed in detail in Chapter IV, expected annual holding cost estimates should be considered to reflect the expenses incurred to maintain a unit of an item in inventory. Estimates should be in terms of a percentage of the average annual value of the operating level of inventory.

Holding costs are not specifically calculated in the MICS system because the MICS software does not attempt to minimize average annual total variable costs in

determining stocking objectives. However, the average value of inventory is reported on the semi-annual stratification report. This value is also used by MICS to calculate the rate of Bulk Inventory Turnover, determined by dividing the annual sales by the average annual inventory value.

Inventory managers in medical treatment facilities are asked by BUMED to track Bulk Inventory Turnover. The desired goal is to turn total inventory at least 4.8 times annually [Ref. 17]. This goal implies a total variable cost concern but not an explicit cost constraint in the MICS software model.

The decision not to determine the average annual holding costs value implies that holding cost is not a critical parameter in determining line item stocking objectives by the MICS developers. The inventory manager may have incentive to keep the inventory value down (at least at the time the stratification report is run) so the Bulk Inventory Turnover value is higher, but there is no indication that the stocking objectives for a given item consider explicitly the holding costs of the item.

A medical inventory may be arguably different from many other types of inventories due to both the shelf life and essentiality of the items. Pharmaceutical items, for example, are costly, high demand, critical items. However, attempting to reduce the total costs of holding inventory by holding only a few, high cost items could result in fewer than are really required for adequate patient care support. Instead, a model that sets the objective to minimize total variable costs, including holding and backorder costs which reflect the item's essentiality or criticality, should be used to determine Q and R.

3. Ordering

As explained in detail in Chapter IV, ordering costs reflect the expenses incurred to perform the tasks of requirements determination, requisition preparation and recording, receipt processing, stowage of material, and accounting for transfer of funds between source and activity.

Ordering costs are not tracked or calculated in the MICS environment for the same reason that holding costs are not specifically calculated; the figures are not used in determining stocking levels. Because of the different procedures used to procure an item, including the degree of automation, and the variation in the nature of storage requirements of some of the material, the costs associated with ordering may widely.

4. Shortage Cost

As explained in Chapter IV, little guidance is provided by DoD regarding treatment of shortages and the associated backorder costs. In particular, the DoD Material Management Regulation [Ref. 10] does not provide any specific guidance for estimating shortage costs for either wholesale or retail levels of inventory management.

Some form of shortage cost should be used to establish stocking objectives. This will allow inventory managers to provide a certain level of customer service. For example, raising a reorder point will reduce the risk of stockout; lowering the reorder point will increase stockout risk. The ability to understand how varying a shortage cost factor affects the reorder point is critical in meeting the changing needs of the organization that the inventory supports.

No type of stockout cost or backorder cost is estimated, tracked or calculated by MICS. Although the system does not track backorders, a stockout has some real and implied costs. In addition, at a Navy Medical Treatment Facility the actual stockout cost may include:

* the costs associated with obtaining an open purchase;
* a substitution cost from using a possibly higher priced item;
* the costs of rescheduling a patient;
* the costs of sending a patient to be treated in a civilian facility (referred to as *Patient Disengagement*); and
* the death of a patient.

Instead of using a shortage cost factor or specifying customer service levels in the setting of stocking objectives, the MICS system attempts to measure, after the fact, the customer service by provided based on BUMED criteria. BUMED has set goals for the inventory manager regarding these criteria. A summary is provided in Table 6-1. [Ref. 17]

Table 6-1. Measures of Effectiveness (MOE's)

Effectiveness Indicators:	BUMED Goal:
NET EFFECTIVENESS - % of requisitions for carried material filled from inventory	85%
GROSS EFFECTIVENESS - % of all requisitions filled from inventory (point of entry)	65%
NOT-IN-STOCK RATE - % of total requisitions unfilled due to zero on-hand balance	< 4%
ZERO BALANCE RATE - % of carried line items having a zero on-hand balance	< 5%

There is a problem in using these customer service MOE's before the fact in setting stockage levels.. As discussed in Chapter II, estimating the *rate* at which customers *will not* be served is not the same as measuring the *risk* at which customers *may not* be served. However, even the UICP and VOSL models use Net Effectiveness goals in setting stock levels.

The MOE rates shown above serve only as a scorecard to effectiveness of the inventory manager's decisions for a specific period of time after the decisions have been made. The probability that a stockout will occur before an order arrives is a more serious measure of customer service for a health care organization because stockout can have serious consequences. Thus, it is important in setting the reorder point to understand varying the reorder point affects the probability of a stockout.

D. CONCLUSION

This chapter provides an overview of the Medical Inventory Control System (MICS), the tool used by medical inventory managers in Navy Medical Treatment Facilities. MICS, overall, severely limits the medical item manager's ability to control costs and provide good customer service. Unlike the UICP and VOSL models that implement algorithms which vary order quantities, reorder points and safety levels among stock items in order to minimize total annual variable costs, MICS algorithms have essentially "fixed" stocking objectives with respect to the determination of the low and high level multipliers. Although the item manager may adjust the inputs, he must do so manually and without the benefit of a system providing data regarding demand variance or procurement lead time. In addition, there is no indication that the reorder points are set to

meet any desired level of customer service. The next chapter reviews inventory data taken from the Naval Medical Center, Oakland to evaluate the implications of the system limitations which MICS presents.

VII. MICS AT NAVAL MEDICAL CENTER, OAKLAND - CASE STUDY

The intent of this chapter is to provide further analysis of the MICS software with data collected from the Naval Medical Center, Oakland. There is no intention by this author to suggest conclusions regarding the quality of inventory management at the Naval Medical Center, Oakland. In discussing the MICS software and inventory management system at the hospital, the author's purpose is to discuss possible implications given the nature of the inventory model used within the MICS software.

A. BACKGROUND

Naval Medical Center, Oakland is an acute care medical/surgical treatment facility. It is one of four of Navy Medicine's teaching hospitals. The facility has an operating bed capacity of 225 with wartime expansion capacity to 625. The average inpatient care occupancy in Fiscal Year 1993 was estimated at 78%. [Ref. 3] Outpatient care is provided in both the main hospital and in nine branch clinics. Total outpatient visits are estimated at 280,000 annually. The medical material requirements to support this type of inpatient and outpatient care are extensive.

The Material Management Department falls under the direction of the Director for Logistics. Material is managed in a Defense Business Operating Fund (DBOF) inventory by the Stock Control Division. The Stock Control Division manages an average of 1300 line items using the MICS software. The software allows the five inventory managers to control stock levels, order, issue and receive supplies. Each inventory manager is assigned a specific classes of material and manages approximately 300 different line items.

All material is received at the loading dock of the Stock Control's supply warehouse which is located separately from the main hospital building. The warehouse space totals 194,000 cubic feet, including freezer and refrigerator space. The average value of the inventory during fiscal year 1994 was approximately $2.0 million and occupied approximately 87% of available cube space.

B. MICS AT OAKLAND

Naval Medical Center, Oakland is using MICS Version 4.1. When the new version was installed in Fiscal Year 1993, the hospital chose to have inventory levels dropped from high and low levels of five and two months, respectively, to high and low levels of four and two months. Oakland was informed, along with the other sites receiving the new version, that once the software was installed that manual inventory level changes could be made at any time. Changes were to be made only to the high and low level multipliers discussed in the previous chapter.

The ability of the Version 4.1 to allow variation in stocking objectives among different line items is considered a marked improvement which allows for better customer service. However, lead time information, critical to setting the stock parameters, is not tracked by the automated system. Lead time data is tracked, if at all, manually. Clearly, this is a serious shortcoming of the system. It would be more logical and efficient if the MICS software was able to first collect data and then suggest optimal reorder points and order quantities to the medical inventory manager. At the time of this research, Naval Medical Center, Oakland had not yet changed any inventory levels of the stock items managed by the MICS system from the four and two month levels installed with the new

software.[1]

Certain holding costs and customer service levels are implied by keeping the ordering quantity and reorder point fixed at two months. The next section discusses the implied costs and customer service levels that are associated with the "four and two" high and low levels.

C. IMPLIED COSTS

1. Holding Costs

The formula for the economic order quantity (EOQ) can be used to determine implied holding costs for a line item in inventory. The classic EOQ formula is:

$$Q* = \sqrt{\frac{2DA}{IC}}$$

where:

D = the expected annual demand;
A = the per order cost;
C = unit procurement cost;
I = annual holding cost rate discussed in the previous chapter, and
Q*= "optimal" order quantity.

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[1] It is the author's understanding that the Stock Control Division had taken many stock items out of the MICS generated stock objective system and instead managed those items with a system of manual calculation of the reorder point and order quantities before the MICS Version 4.1 was installed. This strongly suggests that the five and two months high and low levels were not appropriate objectives for those items. By ignoring the MICS fixed parameters, the inventory manager, in effect, factored in varying operating level, safety level and lead time requirements in calculating the reorder point and order quantity. Unfortumately, because no specific algorithm is used for this procedure no further discussion can be provided.

Assuming the MICS two months average demand order quantity is optimal and can be described by the classic EOQ formula, the implied I value can therefore be determined by solving for I in the EOQ formula. The result is:

$$I = \frac{2DA}{CQ^2}.$$

Using this formula, an analysis was conducted for several items in the Naval Medical Center, Oakland inventory. Line items with the highest unit prices were purposely selected. Table 7-1 indicates the holding cost rate implied when the optimal ordering quantity (Q) is assumed to be equal to two months of expected demand and the ordering cost is assumed to $20 per order.[2] The implied holding cost rate under these conditions is quite high for two items (recall that the UICP model uses 23%). For Mannitol 20% 500 ML the implied holding cost rate is 68%. If the optimal ordering quantity was two months of demand, this holding cost rate implies that it costs the

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[2] The complete analysis contained in this chapter assumes that a range of possible ordering costs, from $5 to $50, applies to the Naval medical material management environment. This suggested range is assumed reasonable based upon the length of time, personnel and automation at the Naval Medical Center, Oakland, required to process orders for Federal Supply material using the MICS inventory management system.

inventory manager 68% of the price of Mannitol ($286.96) to hold one unit of it in

Table 7-1. Implied Holding Cost Rates

Item	D	C	A	Q	I
Nitrofurantoin Caps	30	$702.11	$20	5.00	7%
Thiopental 5GR KIT	11	$359.27	$20	1.83	36%
Amidacin Inj 10/PG	38	$579.58	$20	6.33	7%
Piroxicam 500/BT	245	$486.43	$20	40.83	1%
Mannitol 20% 500 ML	5	$422.00	$20	.83	**68%**
Hetastarch Inj Sodch	110	$510.68	$20	18.83	3%
Gemfibrozil 600 MG	773	$340.29	$20	128.83	1%
Enlapril maleate 5M	45	$1,864.98	$20	7.50	2%
Vasotec 10 MB 4000S	221	$1,864.98	$20	36.83	.0003%

inventory for one year. There is nothing unique about Mannitol that would suggest that it would be necessary for the Naval Medical Center, Oakland to purposely incur a higher cost to hold this line item when compared to other pharmaceutical items.

Besides Mannitol, only one other pharmaceutical item analyzed (Thiopental) has a holding cost rate higher than the Navy's recommended rate of 23%. There is also nothing unique about the inventory procedures of this item that would suggest that it was reasonable to assume that a higher holding cost is justified. Thus, an order quantity of more than two months of demand is appropriate.

The three pharmaceutical items analyzed which have the highest annual demand have the lowest implied holding cost rates. This suggests that, given the average annual demand, unit procurement cost and order cost, two months demand as the fixed order quantity may be too high. Realistically, the time value of money is much higher than their implied holding costs. Reducing the order quantity would free up money for use elsewhere. Therefore, the Naval Medical Center should decrease the quantity ordered.

Because ordering costs used in the analysis are estimated, Table 7-2 takes on a different point of view by providing the economic order quantity for a range of ordering cost values and assuming the holding cost rate is the Navy's standard 23%. The order quantity is then expressed as its demand equivalent in months. As discussed in Chapter IV, the 23% holding cost rate may not be the best for Navy medical material but it is the common rate used for other Navy consumables. This analysis illustrates the effect that different ordering costs can have when applied to different line items or within different commands. If the cost of placing an order was $20 then, for example, 3.4 months worth of demand would be the optimal ordering quantity for Mannitol instead of two months. The 3.4 months supply would balance ordering costs with holding costs in this case. Further, this analysis indicates that only two items (Mannitol and Thiopental) had a consistent optimal order quantity (Q*) value greater than two months demand when the ordering cost values (A) were $20 or higher. The high demand, high cost items, on the other hand, had consistently less than one month's worth of demand over the full range of ordering cost values.

D. CUSTOMER SERVICE IMPLICATIONS

As discussed in detail in Chapter II, the customer service level of interest is defined as the probability of being able to meet a customer's demand between the time when the inventory position reorder point has been reached and the order for the item is received by the hospital warehouse (or 1-probability of stockout during procurement lead time or stockout risk). The same line items that were examined in the preceding section were evaluated for the implied stockout risk associated with keeping the safety level fixed at

Table 7-2. Economic Order Quantity Analysis

	A	Q*	Q* monthly	A	Q*	Q* monthly	A	Q*	Q* monthly
NITROFURANTOIN CAPS	$5	1	0.5 mos	$10	2	0.8 mos	$20	3	1.1 mos
THIOPENTAL 5GR KIT	$5	1	1.3 mos	$10	2	1.8 mos	$20	2	2.5 mos
AMIDACIN INJ 10/PG	$5	2	0.5 mos	$10	2	0.8 mos	$20	3	1.1 mos
PIROXICAM 500/BT	$5	5	0.2 mos	$10	7	0.3 mos	$20	9	0.5 mos
MANNITOL 20% 500ML	$5	1	1.7 mos	$10	1	2.4 mos	$20	1	3.4 mos
HETASTARCH IN SODCH	$5	3	0.3 mos	$10	4	0.5 mos	$20	6	0.7 mos
GEMFIBROZIL 600MG	$5	10	0.2 mos	$10	14	0.2 mos	$20	20	0.3 mos
ENALAPRIL MALEATE 5M	$5	1	0.3 mos	$10	1	0.4 mos	$20	2	0.5 mos
VASOTEC 10MB 4000S	$5	2	0.1 mos	$10	3	0.2 mos	$20	5	0.2 mos

	A	Q*	Q* monthly	A	Q*	Q* monthly	A	Q*	Q* monthly
NITROFURANTOIN CAPS	$30	3	1.3 mos	$40	4	1.5 mos	$50	4	1.7 mos
THIOPENTAL 5GR KIT	$30	3	3.1 mos	$40	3	3.6 mos	$50	4	4.0 mos
AMIDACIN INJ 10/PG	$30	4	1.3 mos	$40	5	1.5 mos	$50	5	1.7 mos
PIROXICAM 500/BT	$30	11	0.6 mos	$40	13	0.6 mos	$50	15	0.7 mos
MANNITOL 20% 500ML	$30	2	4.2 mos	$40	2	4.9 mos	$50	2	5.4 mos
HETASTARCH IN SODCH	$30	7	0.8 mos	$40	9	0.9 mos	$50	10	1.1 mos
GEMFIBROZIL 600MG	$30	24	0.4 mos	$40	28	0.4 mos	$50	31	0.5 mos
ENALAPRIL MALEATE 5M	$30	3	0.7 mos	$40	3	0.8 mos	$50	3	0.9 mos
VASOTEC 10MB 4000S	$30	6	0.3 mos	$40	6	0.3 mos	$50	7	0.4 mos

Assumes buys are ACC D,
with fixed cost per order (A),
and holding cost rate equals 23%.

one month and the order and ship time fixed at one month (2 months worth of demand is the reorder point). The results are shown in Table 7-3. Assuming a Normal probability distribution for demand during lead time, the implied Normal deviate z value can be determined from the following formula:

$$z = \frac{SL}{\sigma_{DLT}}$$

where:

SL = safety level, and;

σ_{DLT} = standard deviation of lead time demand.

The standard deviation of monthly demand has been derived from historical quarterly data as shown in Table 7-3.

Once the implied z value is determined, the associated stockout risk is;

Stockout Risk = (1 - Right tail area under the Normal distribution associated with the Normal deviate z value).

The resulting stockout risk values range from zero to 26% for this sample. This range indicates that probability of a stockout during procurement lead time (the stockout risk) may vary widely for items managed by MICS.

Reorder point values for a stockout risk of 5% are calculated in Table 7-4. For a 5% risk the z value is 1.645, and R = mean demand during order/ship time + 1.645 *σ_{LDT}. Table 7-4 indicates that if 5% was used as the maximum stockout risk, then the reorder points would need to be changed from two times the average monthly demand for the stock items analyzed to the amount indicated. A comparison of the current reorder point and the reorder point with a 5% risk of stockout are summarized in Table 7-5. In some

Table 7-3. Evaluation of Stockout Risk

Nomenclature/Unit of Issue		unit price	quarterly demand 1	2	3	4	5	6	7	total dem	avg quart dem	avg monthly dem	sample error dem	std dev monthly dem	implied z value	implied stockout risk
NITROFURANTOIN CAPS	BT	$702.11	9	13	0	18	4	9	8	61	8.7	2.90	5.8	3.36	0.8641	19%
THIOPENTAL 5GR KIT	PG	$359.27	4	2	2	3	2	3	3	19	2.7	0.90	0.8	0.44	2.0731	2%
AMIKACIN INJ 10/PG	PG	$579.58	11	7	8	14	6	25	12	83	11.9	3.95	6.5	3.73	1.0587	15%
PIROXICAM 500/BT	BT	$486.43	44	87	54	87	51	94	60	477	68.1	22.71	20.5	11.84	1.9186	3%
MANNITOL 20% 500ML	PG	$422.00	2	3	0	1	3	2	0	11	1.6	0.52	1.3	0.73	0.7130	24%
HETASTARCH IN SODCHL	PG	$510.68	13	14	9	9	2	15	12	74	10.6	3.52	4.4	2.56	1.3780	9%
GEMFIBROZIL 600MG	BT	$340.29	*	205	142	208	140	172	254	1121	160.1	53.38	44.1	25.45	2.0978	1%
ENALAPRIL MALEATE 5M	BT	$1,864.98	*	23	11	40	7	9	2	92	13.1	4.38	14.0	8.06	0.5439	26%
VASOTEC 10MG 4000S	BT	$1,864.98	*	18	23	48	0	90	90	269	38.4	12.81	38.2	22.06	0.5808	25%

* Item not yet carried in DBOF stock. Item added to inventory in 2nd quarter.

Table 7- 4. Evaluation of Reorder Point values when stockout risk = 5%; z=1.645

Nomenclature/Unit of Issue		unit price	avg monthly demand	std dev monthly demand	reorder point	reorder point in months of demand
NITROFURANTOIN CAPS	BT	$702.11	2.9	3.4	8.4	2.9
THIOPENTAL 5GR KIT	PG	$359.27	0.9	0.4	1.6	1.8
AMIKACIN INJ 10/PG	PG	$579.58	4.0	3.7	10.1	2.6
PIROXICAM 500/BT	BT	$486.43	22.7	11.8	42.2	1.9
MANNITOL 20% 500ML	PG	$422.00	0.5	0.7	1.7	3.3
HETASTARCH IN SODCHL	PG	$510.68	3.5	2.6	7.7	2.2
GEMFIBROZIL 600MG	BT	$340.29	62.3	25.4	104.1	1.7
ENALAPRIL MALEATE 5M	BT	$1,864.98	5.1	8.1	18.4	3.6
VASOTEC 10MG 4000S	BT	$1,864.98	14.9	22.1	51.2	3.4

Table 7-5. Summarized Results of Reorder Point Analysis

Nomenclature/Unit of Issue		unit price	current reorder point	stockout risk	adjusted reorder point	stockout risk
NITROFURANTOIN CAPS	BT	$702.11	5.8	19%	8.4	5%
THIOPENTAL 5GR KIT	PG	$359.27	1.8	2%	1.6	5%
AMIKACIN INJ 10/PG	PG	$579.58	7.9	15%	10.1	5%
PIROXICAM 500/BT	BT	$486.43	45.4	3%	42.2	5%
MANNITOL 20% 500ML	PG	$422.00	1.0	24%	1.7	5%
HETASTARCH IN SODCHL	PG	$510.68	7.0	9%	7.7	5%
GEMFIBROZIL 600MG	BT	$340.29	124.6	1%	104.1	5%
ENALAPRIL MALEATE 5M	BT	$1,864.98	10.2	26%	18.4	5%
VASOTEC 10MG 4000S	BT	$1,864.98	29.9	25%	51.2	5%

cases, like Nitrofurantoin Caps, the reorder point would be raised to bring the stockout risk down from 19% to 5%. In other cases, like Gemfibrozil, the reorder point could be lowered to increase the risk of stockout from 1% to 5%.

This analysis is not meant to suggest that a risk factor of 5% is better than current actual risks resulting from the two months reorder point. However, only when the risk of stockout is 5% can customer service levels be said to be held at 95%. The determination of the optimal risk was not included in this analysis since it would need to consider ordering, holding, and stockout costs.

E. CONCLUSION

This chapter discussed possible implications arising from the inventory levels used in MICS. These implications were based on data collected from the Naval Medical Center, Oakland DBOF inventory records between April 1992 and December 1993 and focused on implicit costs and customer service levels. The implied holding cost rates varied widely; sometimes far above the Navy's standard value of 23% for consumable items. Stockout risk was found to also vary tremendously. This indicates that stocking objectives are not targeted to a desired level of customer service.

The ability of the inventory manager to alter all order quantity multipliers and reorder points can be a benefit. However, the inventory manager is lacking automated tracking of order and shipping lead time and demand variability so that he can adjust his reorder point based on these data. Also, the inventory manager has not been specifically given the basis to judge what the criterion should be for stock availability or order quantity. Stock availability should be based upon the customer service levels established

by the medical treatment facility. Order quantity should be based upon demand, ordering cost, holding cost and unit procurement cost. Under the current circumstances the inventory manager has an imposing challenge. He is asked to keep variable inventory costs down and also to satisfy his customer, yet he has no method of determining the trade off between these two goals. This chapter has provided a framework with which to analyze implied holding costs and stockout risks resulting from use of the MICS inventory management system.

VIII. PRIME VENDOR AS A RESPONSE TO BETTER CUSTOMER SERVICE

The purpose of this chapter is provide an overview of the DoD Prime Vendor Program. A background discussion of the program is provided along with a discussion of the customer service and cost implications for a medical treatment facility adopting this new business practice as an alternative inventory management tool. With the implementation of the Prime Vendor Program, Naval medical treatment facilities will likely experience both a reduction in some costs and a short term increase in others. A major advantage of this program is reduced procurement lead times. This allows for better customer service, lower inventory levels, and virtually complete elimination of disposal costs.

A. PROGRAM BACKGROUND

The General Accounting Office (GAO) made a specific recommendation to the Senate Subcommittee on Oversight of Government Management in December 1991 that DoD hospitals "accelerate use of private-sector health care business practices, especially the use of Prime Vendor Contracts" to reduce both wholesale and retail medical inventories. [Ref. 8; p. 5] Following the GAO recommendation, in March 1992 the Defense Personnel Support Center (DPSC), Defense Logistics Agency, established a task force to suggest changes in business practices for wholesale management of medical supplies in DoD. The result was the Prime Vendor Concept which was implemented for the acquisition and distribution of medical supplies DoD wide. [Ref. 26; p. 18] The first Navy medical treatment facility Prime Vendor orders were transmitted in April 1993 by

the National Naval Medical Center (NATNAVMEDCEN), Bethesda, MD to McKesson, the company established as their pharmaceutical Prime Vendor.

DoD plans to be using Prime Vendor contracting practices in all CONUS medical treatment facilities by the close of calendar year 1996. Contracts are also being let in Europe, the Far East and the Pacific Regions. Table 8-1 lists the implementation schedule proposed by DPSC for pharmaceutical and medical/surgical prime vendor contract awards as of March 1995. [Ref. 28]

DoD prime vendor contracting is an adaptation of the Japanese *Just-in-Time* (JIT) philosophy developed in the 1950's. JIT systems seek to improve the quality of processes and to eliminate waste and wasteful activities such as holding inventories, long lead times and inspection upon receipt. [Ref. 24; p. 1-2] Waste in JIT systems is defined as "anything other than the minimum amounts of equipment, materials, workers and time which are absolutely essential to production." [Ref. 25; p. 28]

Prime Vendor contracting practices will attempt to eliminate waste by establishing new supplier relationships and by revising traditional methods of medical line item stock replenishment in both pharmaceutical and medical/surgical stock management. The Bureau of Medicine and Surgery (BUMED) expects that when program implementation has been completed, average DoD pharmacy inventory levels will have dropped by 40% from 1991 levels and that the total value of medical/surgical inventories carried will be less than 10% of the value carried in 1988. [Ref. 25]

Table 8-1. PRIME VENDOR IMPLEMENTATION SCHEDULE AS OF 17 MARCH 1995

Region	Pharmacy Contract Award Date	Prime Vendor	Medical/Surgical Contract Award Date	Prime Vendor
Bethesda	16 Jan 93	McKesson	11 Jun 93	Owens and Minor
Philadelphia	31 Aug 93	Bergen Brunswig	31 Aug 93	Gen Med
San Diego	31 Aug 93	McKesson	15 April 94	Baxter
San Francisco	31 Aug 93	McKesson	10 Aug 94	McKesson
Tidewater	01 Oct 93	Bergen Brunswig	14 Sep 94	Owens and Minor
Rocky Mts	08 Nov 93	Bergen Brunswig	Sep 95	
Cascades	12 Nov 93	McKesson	Aug 95	
Carolina	02 Jan 94	Kendall	Jan 95	
IL/KY/MO	25 Feb 94	Bergen Brunswig	Nov 95	
Texas	28 Feb 94	Bergen Brunswig	30 Sep 94	Owens and Minor
Panhandle	08 Apr 94	Bergen Brunswig	Oct 95	
FLA/GA	12 May 94	Tennessee	Sep 95	
Mid-west	17 Jun 94	Foxmeyer	Oct 95	
NY/New England	29 Sep 94	Tennessee	Apr 95	
AL/TN/AR	20 Aug 94	Foxmeyer	Nov 95	
Utah/Idaho	30 Sep 94	Amerisource	Apr 95	Amerisource
Dakotas	30 Sep 94	Dakota Drug	Apr 95	Dakota Drug
Montana	Aug 94	McKesson	Apr 95	McKesson
Hawaii	Sep 94	Bergen Brunswig	Jan 96	
Europe	Mar 95	Kendall	Feb 96	
Pacific	Sep 95		Feb 96	

B. HOW PRIME VENDOR WORKS

1. Concept

The philosophy of Prime Vendor is to buy response rather than inventory. A "Prime Vendor" is a single commercial distributor of medical supplies for a group of hospitals in a given geographic region. The contract is a requirements contract established and managed centrally by DLA through DPSC. In the Federal Supply System, this means that the Prime Vendor becomes a required source of supply. If an item is available, and, at a lower cost than offered from DLA depots, then the hospital is required to purchase the item from the Prime Vendor. In addition, even if the item could be obtained at a lower cost through open purchase procedures, the hospital is still required to use the Prime Vendor. Prime Vendor contracts, one for pharmaceuticals and one for medical/surgical supplies, will be contracted in each of 22 regions in a CONUS by DPSC. The job of the Prime Vendor is to purchase and warehouse medical supplies from the manufacturer. This will, in effect, allow medical treatment facilities to only be concerned with ordering, receiving and distribution.

2. Ordering

As discussed in earlier chapters, the traditional method of ordering stock carried in the Federal Supply System for a Navy Medical Treatment Facility is to send the order electronically using MICS through the Defense Automated Addressing System (DAAS). DAAS forwards the order to the appropriate inventory control point. Most of the orders, because they are 9 cog (pharmaceuticals), are forwarded to DPSC, the DLA Medical inventory control point. DPSC will then send a material release order to an appropriate

DLA depot which, in turn, ships the material to the hospital. The complete "order to receipt" process typically takes thirty days.

After a Prime Vendor contract is put into place by DLA, the Prime Vendor ordering software is installed in the hospital, giving the facility the ability to electronically place an order with the Prime Vendor. The Prime Vendor electronic order entry system allows the hospital to "shop" for the items available to them under the Prime Vendor requirements contract and allows the manufacturer to market products electronically. The system displays a price and product catalogue for all the manufacturers that have negotiated pricing agreements with DoD. These pricing agreements, called Distribution and Pricing Agreements (DAPA's), are negotiated with each manufacturer by DPSC. DAPA's are held with both large and small businesses for a large scope of products, including brand name products.

Payment for the order is also made electronically. However, the ordering software is not part of, nor does it interface with, the MICS software . This creates an inefficiency. To process payment for an order, the hospital transmits MILSTRIP payment data to DPSC. This means that after a hospital places an order directly into the Prime Vendor ordering system, the facility must then also key in the necessary information to MICS to notify DPSC of the dollar value and number of the order so that payment may be processed. After the item has been delivered, the Prime Vendor sends an electronic invoice to DPSC to be matched against the order. DPSC then transfers funds to the Prime Vendor for payment.

C. CUSTOMER SERVICE AND COST IMPLICATIONS

1. DPSC Cost Recovery

A cost recovery charge is added to Prime Vendor purchases to fund DPSC administrative costs associated with contract oversight and payment processing. The charges are a percentage of the net cost of items purchased and are added to the invoice by the Prime Vendor when billing the medical treatment facility. Charges vary by region, but fall within the ranges of -.07% to 1.0% for pharmaceuticals and 3.5% to 7.0% for medical/surgical material. [Ref. 27][3]

In effect, the Prime Vendor charges are a surcharge to the DAPA price arranged with the manufacturer. In Chapter VI, surcharges associated with traditional sources of supply, DLA and GSA, were discussed. The Prime Vendor surcharges fall considerably below the DLA surcharges added to the unit price for AAC D items for both pharmaceutical and medical/surgical, which are currently 14.2% and 26.7%, respectively. However, for the AAC H items (EDI/SPSDE), which are primarily medical/surgical supplies, the surcharge is 5 to 5.9%, so the Prime Vendor surcharge in some regions may be higher. As mentioned earlier, the DLA AAC L surcharge is 7%, which is the surcharge added to open purchase items stocked in the DBOF warehouses located at the Medical Treatment Facilities. Sometimes manufacturers attempt to sell AAC L items directly to the DBOF item managers at the hospitals below the DAPA prices if they are, for example,

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[3] In some instances the pharmaceutical Prime Vendor contract has been let with a negative or zero cost recovery factor. For all contracts, the Prime Vendor claims to obtain revenue through a "float" delay in payment terms. The Prime Vendor has 30 days in which to pay the DAPA holder, but receives payment from DPSC within 15 days. (Ref. 1) The negative cost recovery factor in the pharmaceutical contract is assumed to be a result of the typically high price per unit of pharmaceutical stock.

attempting a large scale inventory reduction. In this case total effective price per unit, which is unit price plus 7% surcharge, could potentially be lower than the Prime Vendor total price per unit. This option, however, is precluded by the structure of the Prime Vendor Program. By DLA letting a requirements contract with the Prime Vendor and therefore establishing the Prime Vendor as a required source of supply, hospital DBOF item managers must obtain available stock from the Prime Vendor even if a lower price could be obtained directly from the manufacturer.

2. Holding Costs

The intended use of the Prime Vendor Program is to order only what will be needed for a short period of time, say, three to four days supply. When the item is delivered to the hospital it is supposed to be turned over directly to the end user, either the pharmacy, ward, clinic, or tenant command. No item that is ordered through the Prime Vendor is to be stocked in the hospital's warehouse for reissue to the customer. This means that the holding costs for the Prime Vendor items are eliminated. Overall holding costs in the hospital inventory should therefore decline. Indeed, if the Prime Vendor system is used for high unit cost pharmaceuticals and medical/surgical items, the decrease in holding costs for the overall inventory should be drastic.

In July 1994, DPSC surveyed nine medical treatment facilities that had at least one Prime Vendor contract in place for several months to estimate inventory reductions resulting from Prime Vendor program initiatives. [Ref. 27] DPSC determined that the average days of inventory in DBOF warehouses fell overall from approximately 70 to 10 days, a reduction of 85%. The average days of inventory in MTF pharmacies fell from

approximately 30 to 5 days, a reduction of 81%. DPSC also determined that the average number of line items held in DBOF warehouses annually fell from 2,600 to 1,800, a reduction of 69%, and that the average dollar value of those inventories fell 52%, from $6.4 million to $3.3 million. Forecast error/obsolescence/losses savings were also determined by the DPSC survey. For the medical treatment facilities which provided data, the average number of expired line items which had to be destroyed annually fell from 98 to 26, a reduction of 73.4%. This savings correlated to an average of $100,000 saved per MTF; a ***98%*** drop in the average dollars lost due to forecast error/obsolescence/losses.

3. Ordering Costs

Annual ordering costs can be expected to rise overall with the Prime Vendor program due to the frequency of re-ordering. Ordering costs will drop per order, but not as much as the Just-in-Time theory implies (i.e., essentially zero), because of inherent process inefficiencies. Unlike MICS managed item automatic inventory ordering, Prime Vendor items will not have a standardized automated system to determine which items need to be ordered. This results in manual counting and then keying data into the prime vendor software in addition to the inefficiencies in processing payments to the Prime Vendor mentioned earlier. Moreover, the inventory manager will have to both place orders and receive the items more often. The additional man-hours required for both tasks will result in higher ordering costs. No formal attempt has been made by DPSC, or any other agency, to calculate ordering costs associated with the Prime Vendor initiatives. The amount of stock purchased through the Prime Vendor Program, in terms of days of demand, varies among the facilities that have implemented the program. This suggests

Table 8-2. Prime Vendor Economic Order Quantity Analysis

		D	C	A	I	Q* daily
NITROFURANTOIN CAPS	BT	30	$702.11	$20	500%	7.0
THIOPENTAL 5GR KIT	PG	11	$359.27	$20	500%	16.2
AMIDACIN INJ 10/PG	PG	38	$579.58	$20	500%	6.9
PIROXICAM 500/BT	BT	245	$486.43	$20	500%	2.9
MANNITOL 20% 500ML	PG	5	$422.00	$20	500%	22.2
HETASTARCH IN SODCH	PG	110	$510.68	$20	500%	4.3
GEMFIBROZIL 600MG	BT	773	$340.29	$20	500%	2.0
ENALAPRIL MALEATE 5M	BT	45	$1,864.98	$20	500%	3.5
VASOTEC 10MB 4000S	BT	221	$1,864.98	$20	500%	1.6

		D	C	A	I	Q* daily
NITROFURANTOIN CAPS	BT	30	$702.11	$50	500%	11.1
THIOPENTAL 5GR KIT	PG	11	$359.27	$50	500%	25.6
AMIDACIN INJ 10/PG	PG	38	$579.58	$50	500%	10.8
PIROXICAM 500/BT	BT	245	$486.43	$50	500%	4.7
MANNITOL 20% 500ML	PG	5	$422.00	$50	500%	35.0
HETASTARCH IN SODCH	PG	110	$510.68	$50	500%	6.8
GEMFIBROZIL 600MG	BT	773	$340.29	$50	500%	3.1
ENALAPRIL MALEATE 5M	BT	45	$1,864.98	$50	500%	5.6
VASOTEC 10MB 4000S	BT	221	$1,864.98	$50	500%	2.5

		D	C	A	I	Q* daily
NITROFURANTOIN CAPS	BT	30	$702.11	$100	500%	15.7
THIOPENTAL 5GR KIT	PG	11	$359.27	$100	500%	36.2
AMIDACIN INJ 10/PG	PG	38	$579.58	$100	500%	15.3
PIROXICAM 500/BT	BT	245	$486.43	$100	500%	6.6
MANNITOL 20% 500ML	PG	5	$422.00	$100	500%	49.6
HETASTARCH IN SODCH	PG	110	$510.68	$100	500%	9.6
GEMFIBROZIL 600MG	BT	773	$340.29	$100	500%	4.4
ENALAPRIL MALEATE 5M	BT	45	$1,864.98	$100	500%	7.9
VASOTEC 10MB 4000S	BT	221	$1,864.98	$100	500%	3.5

		D	C	A	I	Q* daily
NITROFURANTOIN CAPS	BT	30	$702.11	$300	500%	27.2
THIOPENTAL 5GR KIT	PG	11	$359.27	$300	500%	62.7
AMIDACIN INJ 10/PG	PG	38	$579.58	$300	500%	26.6
PIROXICAM 500/BT	BT	245	$486.43	$300	500%	11.4
MANNITOL 20% 500ML	PG	5	$422.00	$300	500%	85.9
HETASTARCH IN SODCH	PG	110	$510.68	$300	500%	16.6
GEMFIBROZIL 600MG	BT	773	$340.29	$300	500%	7.7
ENALAPRIL MALEATE 5M	BT	45	$1,864.98	$300	500%	13.6
VASOTEC 10MB 4000S	BT	221	$1,864.98	$300	500%	6.1

that no formal analysis based on holding cost/ordering cost tradeoffs has been conducted and no formal guidance has been disseminated.

The previous chapter presented and summarized in Table 7-2 the tradeoff analysis between holding and ordering costs which is used in determining the optimal order quantity. That analysis showed how the optimal ordering quantity varied as a function of ordering and holding costs. The analysis is extended here, as shown in Table 8-2, to reflect the optimal ordering quantities one might expect under a Prime Vendor Program. It is implied under the Prime Vendor concept that the holding cost is so high that it is not beneficial to hold any stock. To approximate that assumption, a holding cost rate is set at 500% per year in the classic EOQ model. Again, a range of ordering costs are assumed to reflect possible differences in regional man-hour requirements or labor rates for civil service employees. The analysis shows that when ordering costs are low ($20) the optimal ordering quantity drops as low as 1.6 days demand (Q* daily) for Vasotec and as high as 16 days demand for Thopental. When ordering costs are elevated to $300 the optimal ordering quantity increases to six days average demand and 62 days average demand, respectively. The difference in levels between the two items is, as discussed earlier, a function of the demand for the item and the unit procurement cost in addition to the ordering cost assumed.

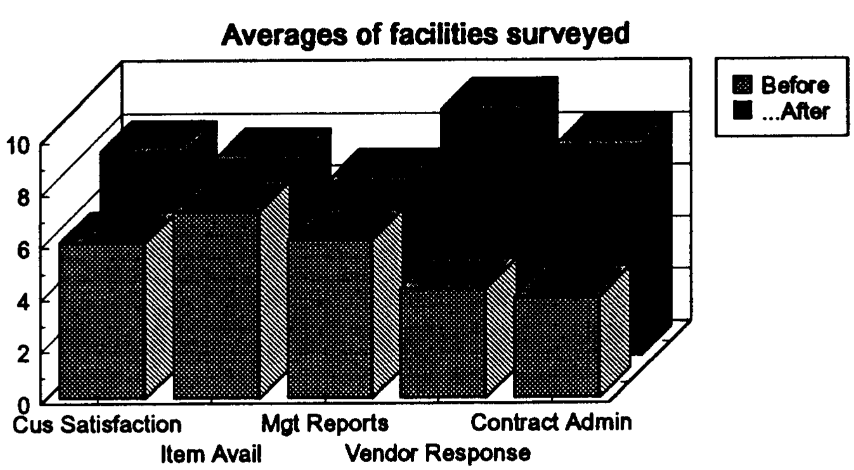
4. Customer Service

The response time built into the Prime Vendor Program is excellent. Orders placed with the Prime Vendor receive electronic confirmation of stock availability within two hours. Service is offered 24 hours a day, 6 days per week. Delivery to the ordering

facility is to take place within 24 hours and the guaranteed fill rate is at least 95%. (Ref. 25) Having immediate stock availability confirmation and rapid delivery drastically reduce the required safety stock. The inventory manager working with Prime Vendor managed items will still need to set the reorder points to account for fluctuations in demand but the demand variances will be tracked in terms of days of demand instead of months.

DPSC has requested facilities that have Prime Vendor contracts in place to rate some of the elements of customer service from one (1) to ten (10) before and after the Prime Vendor Program was established. DPSC determined that all elements of customer service evaluated have improved with program implementation. Figure 8-1 shows that the largest improvements have been in contract administration and vendor response time.

Figure 8-1. Logistics Support; Evaluation Scores Before and After Prime Vendor



source: Defense Personnel Support Command Aug 94

Overall customer satisfaction has increased along with item availability. Routine management reports used as feedback tools are also perceived to have been improved and streamlined from the local reports generated before the Prime Vendor Program was implemented.

D. CONCLUSION

This chapter introduced the concept behind current Prime Vendor Program initiatives and highlighted the effects on variable costs and customer service the program has had since implementation began in Fiscal Year 1993. The program allows orders to be placed with a "Prime Vendor" for stock that was traditionally held in inventory in the hospital warehouse. Holding costs have fallen overall for Navy Medical Treatment Facilities as a result. Similarly, customer service levels have risen due to the rapid response time. Unfortunately, the associated annual ordering costs are higher.

IX. PRIME VENDOR EXPERIENCE AT NAVAL MEDICAL CENTER, OAKLAND

A. INTRODUCTION

The Prime Vendor concept was introduced to the Naval Medical Center, Oakland in November, 1993, through establishment of the requirements contract for pharmaceuticals with McKesson. On August 1, 1994, the contract establishing the medical/surgical requirements was also let to McKesson. As a result of the Prime Vendor Program, Naval Medical Center, Oakland has experienced success in inventory reduction and increased customer satisfaction. This chapter explains how the program was implemented into the Naval Medical Center, discusses the changes in inventory management that have occurred and provides an analysis of cost implications resulting from the Prime Vendor program.

B. PROGRAM IMPLEMENTATION

The major initial step to program implementation was to determine which products were to be obtained using Prime Vendor procurement methods. This entailed a thorough cross referencing of hospital formulary pharmaceutical stock carried in the DBOF inventory with the 25,000 McKesson items that had an established Distribution and Pricing Agreement (DAPA). McKesson stock has a local indexing system in the McKesson hardware/software program. The McKesson system is called *Econlink* and the local index numbers are referred to as *Economost* numbers. McKesson, unlike the DBOF, does not have products indexed by National Stock Numbers (NSN). McKesson does list

stock with the corresponding National Drug Codes (NDC). NDC's refer to product type and manufacturer.

Matches between DBOF stock products and McKesson products were made by manually researching, and subsequently cross-referencing NSN's to NDC's. If a product match was determined, a price comparison was conducted. If the Prime Vendor price was lower than the DLA Depot price, the item was flagged as a "Prime Vendor item". Once the list of items that would be obtained from the McKesson was established, the process of warehouse stock drawdown was initiated. All requisitions that were submitted to the Material Management Department were carefully reviewed by the Technical Review Division for the appropriate source of supply so that warehouse stock of Prime Vendor items could be depleted before the item was ordered from McKesson.

When a bonafide Prime Vendor order is required, the requisition is forwarded to the Contracting Department. Orders to McKesson may only be placed by a warranted contracting officer. Order entry is typed directly into the Econolink system. When order entry is completed and transmitted to McKesson, a contract obligation is established. Contract payment is initiated when the shipment is received and invoice certification is completed by the pharmacy. As discussed in the previous chapter, no interface exists between McKesson's Econolink system and the Navy's MICS system so consequently invoice information must be input directly into MICS. This task is performed at Naval Medical Center, Oakland by personnel in the Receipt Control Division. MICS transmits the data to DPSC, who pays McKesson electronically and charges the Naval Medical Center, Oakland for the cost of the products purchased plus/minus the cost recovery

factor. In FY93, the contract base year for Naval Medical Center, Oakland, the cost recovery factor was contracted at 0%. The following lists the contracted cost recovery factors for the four option years, or years that the Prime Vendor contract may be renewed by DPSC without additional contract negotiation: [Ref. 1]

Cost Recovery Factor	
Option Year 1	0%
Option Year 2	-.03%
Option Year 3	-.05%
Option Year 4	-.08%

C. PRIME VENDOR RESULTS

Table 9-1 compares pre-Prime Vendor with Prime Vendor inventory management and customer service elements as of September, 1995. Before the Prime Vendor Program, the pharmacy ordered pharmaceutical supplies from the hospital's MICS managed warehouse. The hospital warehouse inventory managers would obtain and stock pharmaceutical supplies from a number of sources, including the DLA depots and directly from the manufacturer using DBOF to fund the stock item purchases. As discussed earlier, the management of the warehouse's pharmaceuticals with MICS does not result in optimal stocking levels nor necessarily provide the ability to meet established customer service levels. After the implementation of the Prime Vendor Program, the average number of line items carried in the pharmacy and the hospital warehouse fell 13.6% and 84%, respectively. The corresponding average dollar value of on-hand inventory fell $700,000 (46.7%) in the pharmacy and $899,679 (81.8%) in the warehouse. The average number of days of inventory carried in the pharmacy fell from between 10 and 15 to

Table 9-1. Prime Vendor Comparative Analysis

Critical Area	Pre-Prime Vendor	Prime Vendor	Percent Change	Effect
Average number of line items in pharmacy	2,200	1,900	13.6% decrease	+
Dollar value of average number of line items in pharmacy	$1,500,000	$800,000	46.7% decrease	+
Average # of days inventory held in the pharmacy	10-15	4-7	50% decrease	+
Average # 6505* line items in DBOF warehouse	658	105	84.0% decrease	+
Dollar value of average # 6505 line items in DBOF warehouse	$1,100,000	$200,321	81.8% decrease	+
Average # of days of 6505 inventory held in the DBOF warehouse	120	60	50% decrease	+
Average # of 6505 line items destroyed monthly	2-4	0		+
Average dollar value of 6505 line items destroyed monthly	$400	0	100% decrease	+
Average pharmacy fill rate	90%	98%	8.9% increase	+
Customer response time for stock availability inquiry	highly variable	two minutes		+
Turnaround time for pharmacy between requisition submission and material receipt	24 hours	16-19 hours	25% decrease	+
Receipt process time	10 minutes	15-45 minutes	200% increase	-
Order technical review/ order entry	0-10 minutes	3 hours	1700% increase	-

*Note: 6505 is the Federal Stock Class (FSC) for pharmaceutical material. This is the first four numbers of the National Stock Number (NSN) for all pharmacy items carried in a DBOF warehouse.

Naval Medical Center, Oakland
September, 1995

between 4 and 7 while the average number of days of warehouse inventory fell from 120 to 60. The number of line items destroyed fell to zero from two to four per month, saving approximately $400 a month.

The reduction in average inventory levels in the pharmacy and the hospital warehouse is a direct result of the increase in customer response possible with McKesson as the Prime Vendor. Average fill rate for pharmacy orders has risen from a 90% fill rate when supplies were obtained from the hospital warehouse to a 98% fill rate with McKesson. Customer inquiries regarding stock availability are answered by McKesson, on-line through Econolink within two minutes. Warehouse response, through MICS or by phone, was highly variable, with as much as a full day to satisfy a customer query. Orders are filled by McKesson within 16 to 19 hours after the orders are placed. This rapid pace is consistent. The warehouse could frequently fill a pharmacy order within one day, but this was dependent upon factors such as stock availability as well as manning and other workload requirements.

There has been an increase of order and receipt processing time with the Prime Vendor program. Order building, technical review and input to Econolink may require between 3 and 6 hours daily and several different personnel. However, placing, transmitting, issuing and receiving orders in the MICS software requires only a few minutes and keystrokes by one inventory manager. The subsequent stock issue of the warehouse items to the pharmacy typically requires one DBOF warehousemen spending approximately two hours directly after the order is received to pull and deliver the stock items ordered.

D. COST ANALYSIS

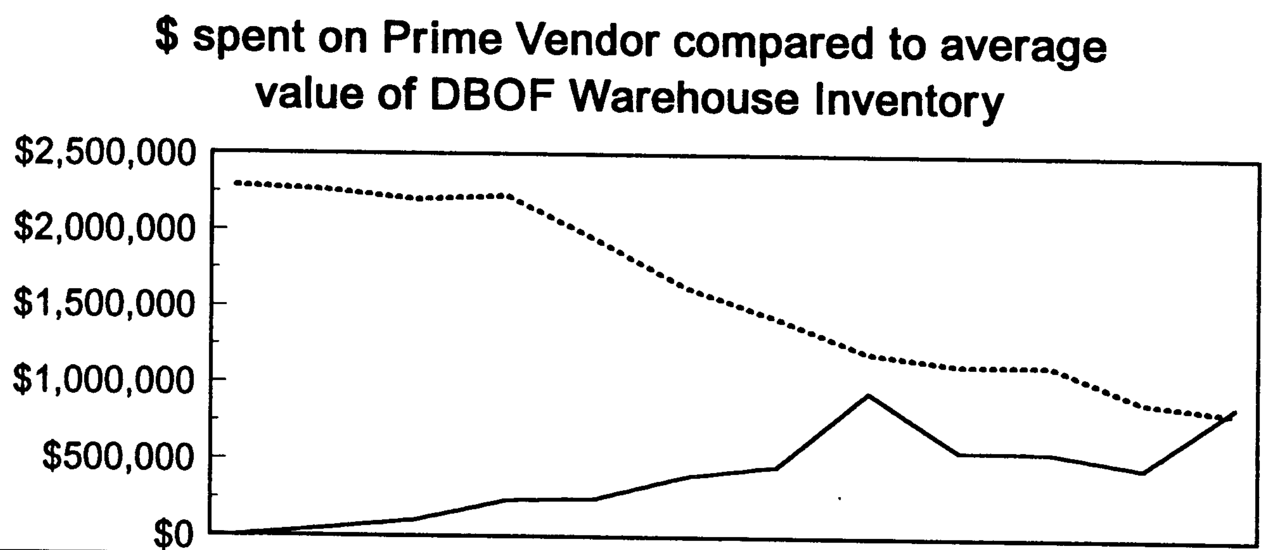
From the data collected in this research, there is evidence of some cost savings.

1. Holding Cost

The most dramatic effect of the Prime Vendor Program is the lowered hospital warehouse inventory levels as Prime Vendor flagged stock items were depleted from the warehouse and purchased from the Prime Vendor during implementation. Figure 9-1 provides a comparative analysis of the total dollars spent with McKesson compared to the dollar value of the inventory in the warehouse each month during the initial Prime Vendor Program implementation. The rate of stock item transfer from warehouse supplied to McKesson supplied stock items from 15 November 1993 to 30 September 1994 was 29 items per month. In September 1994, 401 of the 658 (60.9%) FSC 6505 line items had been identified to be fully converted to Prime Vendor source of supply. Of the 401, 314 had been reduced to a zero balance in the warehouse and were then being obtained strictly from McKesson.

The effect of hospital warehouse DBOF inventory reduction and the associated reduced holding costs was not a direct cost savings to the Naval Medical Center but instead, a one time reduction in overall inventory levels. DBOF holding cost savings have therefore been experienced by DoD through an overall reduction in DLA inventories. However, the Naval Medical Center, Oakland did experience direct reduced holding costs in the pharmacy stockroom. The average pre-Prime Vendor holding cost per year is calculated by multiplying the dollar value of the average number of line items in the pharmacy from Table 9-1 by the Navy's suggested holding cost rate for consumables.

Figure 9-1. Naval Medical Center, Oakland Prime Vendor Program...



	OCT 93	NOV	DEC	JAN 94	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Prime Vendor —	0	48,733	103,323	231,389	250,839	394,687	462,384	945,232	569,343	558,868	460,974	869,369
Warehouse Inventory --	2,285,333	2,261,984	2,196,856	2,225,167	1,938,272	1,626,561	1,427,824	1,200,137	1,126,170	1,127,436	886,785	823,475

program initiated 15 Nov 93

$$\$1{,}500{,}000(.23) = \$345{,}000.$$

With the Prime Vendor Program, the average holding cost has fallen to:

$$\$800{,}000(.23) = \$184{,}000.$$

As indicated, the average number of days of inventory held in the pharmacy fell from between 10 and 15 days to between 4 and 7 days for most items after the Prime Vendor Program was implemented. The average value of daily issues in the pharmacy is $22,000. Therefore, the average savings in terms of days of inventory is between $132,000 and $176,000. [Ref. 13]

2. Shortage Cost and Stockout

The 98% average fill rate experienced with McKesson filling the pharmacy's purchase orders means that the pharmacy can be more certain that they will receive what they order, when they need it, with more certainty than when they ordered from the hospital's warehouse. The order and ship time associated with a McKesson order is consistently between 16 and 19 hours, replacing the wide variance of between 3 hours and one week order and ship time from the hospital's warehouse. Therefore, assuming again that lead time demand is approximated using the Normal probability density function, the risk associated with the pharmacy experiencing a stockout is less than pre-Prime Vendor, ceteris parabus. However, the pharmacy has reacted to the consistency in the ordering cycle by lowering reorder points for some less critical stock items. This will, in effect, increase the overall stockout risk at the hospital. In the past, the pharmacy had ordered "as needed" from the warehouse where the stock was held and managed by MICS. That is, the pharmacy was not calculating optimal reorder points. If

the pharmacy miscalculated requirements, the warehouse could expedite an order or even make emergency issues at night or on weekends. The responsibility for maintaining the ready for issue stock belonged to the warehouse in the MICS environment. In this case the "real" risk of stockout was managed by the warehouse not the pharmacy. With the warehouse inventories depleted, the pharmacy is now responsible for setting reorder points to ensure stock is available as needed on a daily basis and throughout weekend and holiday periods when the Prime Vendor will not deliver. Because pharmacy stocking objective decisions are not automated or based on any clear algorithm, then is it clear that there is no standard implemented in the pharmacy's stock item management for aligning customer service levels to stock parameters. The warehouse item managers using MICS had the dilemma of not having the tools in MICS to effectively set stock parameters to meet desired service levels. This problem has, in effect, been *shifted* to the pharmacy supply technicians and pharmacists, not eliminated, by the introduction of the Prime Vendor. It is therefore inconclusive in the scope of this research to determine whether the overall risk of stockout has decreased as a result of the implementation of the Prime Vendor program in the Naval Medical Center, Oakland pharmacy.

3. Ordering Cost

As discussed in depth in Chapter IV, ordering costs are a function of the procedures involved in requirements determination, requisition preparation and recording, receipt processing and stowage of material. Synergy Inc., suggests that ordering costs may be calculated by identifying and totaling the expenses incurred to the perform each of these tasks. Table 9-2 uses the Synergy, Inc., general approach to develop cost figures for

Table 9-2. Ordering Costs Before and After Implementing Prime Vendor

(Analysis of costs incurred to obtain similar and stock in pharmacy)

Before Prime Vendor

Process:	DBOF requirements determination and requisition preparation	
Average GS level:	5	
hours to complete process:	0.1667	
average wage:	$12.34	
process order cost:		$2.06
Process:	Ordering for DBOF replenishment	
Average GS level:	5	
hours to complete process:	0.1333	
average wage:	$12.34	
process order cost:		$1.65
Process:	Material receipt and stowage	
Average WG level:	5	
hours to complete process:	0.5000	
average wage:	$14.81	
process order cost:		$7.41
Process:	Pharmacy requirements determination and requisition preparation	
Average GS level:	5	
hours to complete process:	1.5000	
average wage:	$12.34	
process order cost:		$18.51
Process:	Processing DBOF material release order	
Average GS level:	5	
hours to complete process:	0.1667	
average wage:	$12.34	
process order cost:		$2.06
Process:	DBOF stock pull and delivery to pharmacy	
Average WG level:	5	
hours to complete process:	1	
average wage:	$14.81	
process order cost:		$14.81
Process:	Material receipt and stowage	
Average GS level:	5	
hours to complete process:	0.5000	
average wage:	$12.34	
process order cost:		$6.17
Process:	Invoice processing	
Average GS level:	5	
hours to complete process:	0.1667	
average wage:	$12.34	
process order cost:		$2.06
TOTAL COST		$54.71

Prime Vendor

Process:	Pharmacy requirements determination and requisition preparation	
Average GS level:	5	
hours to complete process:	1.5000	
average wage:	$12.34	
process order cost:		$18.51
Process:	Technical Review	
Average GS level:	6	
hours to complete process:	1.0000	
average wage:	$11.79	
process order cost:		$11.79
Process:	Ordering via McKesson's Econolink*	
Average GS level:	9	
hours to complete process:	1.5000	
average wage:	$15.41	
process order cost:		$23.12
Process:	Material receipt and stowage	
Average GS level:	5	
hours to complete process:	0.5000	
average wage:	$12.34	
process order cost:		$6.17
Process:	Invoice processing	
Average GS level:	5	
hours to complete process:	0.6000	
average wage:	$12.34	
process order cost:		$7.40
TOTAL COST		$66.99

before and after the implementation of Prime Vendor ordering procedures for pharmaceuticals at the Naval Medical Center, Oakland. [Ref. 3, 13, 35] The analysis represents the average cost incurred to obtain the same stock items through the different ordering procedures. The pre-Prime Vendor scenario included the procedures for the hospital's warehouse DBOF replenishment followed by the pharmacy requisitioning for those supplies. Although the pre-Prime Vendor procedures were more complex, the total average costs per order incurred was still lower by $12.28 than the Prime Vendor ordering procedures. As expected, the frequency at which the Prime Vendor ordering procedures occur did increase from approximately 3 orders placed per week for stock issues from the warehouse to daily (5 times per week) for Prime Vendor stock ordering. This increased frequency does not appear significant.

4. Purchase Price Differential

One method of evaluating cost savings resulting from the Prime Vendor program implementation is through an analysis of the purchase price differential. For the purpose of this research, pharmaceutical stock items that were historically procured from the DLA depot were compared in price to the McKesson price. The annual usage of each of the stock items by the pharmacy was included in the analysis of possible savings. The estimate of direct savings to the pharmacy budget for fiscal year 1994 was $652,745. Both the DLA depot and McKesson prices include a surcharge over the Federal Supply Schedule and Distribution and Pricing Agreement prices. The price differential saving is a result of both unit price differences and the lower surcharge added to Prime Vendor Purchases (1% vice 14.2%).

E. CONCLUSION

This chapter analyzed some of the effects of the Prime Vendor initiative on inventory management at the Naval Medical Center, Oakland. This research concludes that significant inventory reductions have resulted from the Prime Vendor Program implementation. As a result, holding costs have decreased. Also, significant direct budget savings have resulted due to price differentials. Overall ordering costs have increased but may be primarily a result of process inefficiencies. The degree of increased ordering costs is inconclusive in this research. Similarly, although the fill rate is higher, the risk of stockout is undetermined. This is a result of a shift in responsibility for setting pharmaceutical stocking objectives from the MICS environment to the pharmacy.

An important concern is that even though the Prime Vendor program has effectively reduced costs and increased customer service, there is still no method in place with which to minimize total variable inventory costs and align stocking objectives to reach desired levels of customer service. The Prime Vendor Program simply shifts the inventory management questions away from the DBOF inventory managers to the pharmacy technicians and pharmacists.

X. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

This thesis examined current issues in Navy medical inventory management. Specifically, research focused on the current medical consumable inventory management system used in Naval Medical Treatment Facilities and the relatively new Prime Vendor Program initiative.

To provide background for the analyses, early chapters defined and explained the importance of customer service, set forth the assumptions used in the analyses regarding the demand for medical items and defined costs associated with maintaining inventory. Two models used to manage inventory elsewhere in the Navy, the Uniform Inventory Control Program (UICP), used in wholesale level inventory management, and the Variable Operating And Safety Level (VOSL) model, used in intermediate level inventory management, are discussed to serve as basis for comparison for the system used in managing retail level inventory at the Naval Medical Treatment Facilities.

The system currently used by Navy item managers to manage Defense Business Operating Fund (DBOF) inventory at the retail level is called the Medical Inventory Control System (MICS). In this research, the MICS was analyzed in the framework of its relative ability to provide cost containment and meet customer service requirements. Specific case analysis is presented from the Naval Medical Center, Oakland.

Next, the Prime Vendor Concept was presented. The Prime Vendor Program was introduced to the Navy medical material manager in Fiscal Year 1993. The program was a

response to the inventory manager's need to provide improved customer service and reduce costs. The program is reviewed and an analysis of the program as a response to customer service requirements and cost issues has been provided with a specific case analysis of program success at the Naval Medical Center, Oakland.

B. CONCLUSIONS

1. The Medical Inventory Control System (MICS) severely limits the medical item manager's ability to control costs and provide good customer service.

The fixed levels used in MICS does not provide the inventory manager with the controls provided in the UICP and VOSL models. Both the UICP and VOSL item managers have the capability to set order quantities, reorder points and safety levels among stock items to minimize the overall variable costs associated with inventory management while meeting desired service levels.

With a fixed operating level algorithm, the MICS item manager does not differentiate between management of stock items with high or low unit price. This will tend to increase overall holding costs when compared to a variable cost optimization model. With the MICS fixed safety levels and reorder points, the item manager has a variety of inherent stockout risks associated with the variety of items in the inventory. The MICS algorithm has no way of setting stockout risk for any item to meet a desired level of customer service.

The inability of the MICS to provide lead time forecasting forces the item manager to set more subjective reorder points and safety levels. Lead time tracking, if done at all, is done manually.

Lastly, the inability of the MICS to incorporate demand variance into setting safety levels aggravates all variable inventory costs.

2. The Prime Vendor Program is effective in solving many of the cost and customer service problems associated with MICS, but has its own set of problems.

The introduction of the Prime Vendor Program has alleviated some of the problems associated with MICS. As in the Naval Medical Center, Oakland DBOF inventory, nearly 65% of the Federal Supply Class 6505 inventory for many Naval medical treatment facilities has been converted to Prime Vendor as the primary source of supply. This has resulted in reduced variable inventory costs and increased customer service levels. But the Prime Vendor Program introduces a new set of problems, such as:

a) *There is still no method for optimal inventory management and meeting of desired customer service goals.* Inventory management questions that were addressed by the DBOF item managers using MICS have shifted to a different set of item managers. Safety level, reorder point and order quantity questions regarding pharmaceutical stock are now being addressed by pharmacists. They do not yet have the training or tools to manage inventory. The MICS, although inadequate, allowed some indication of when and how much to order. The pharmacies in Naval Medical Treatment facilities do not have any standard inventory management system in place to balance and minimize overall variable inventory costs or to set safety levels to meet desired customer service levels. The one-day delivery by the Prime Vendor does not remove the necessity to optimize spending and establish cost control initiatives, and;

b) *The ordering and payment process in Prime Vendor has inefficiencies.* Orders placed with the Prime Vendor are made on a system that has no connectivity to other information systems used in Navy Medical Treatment Facilities. Payment made to the Prime Vendor is still done using the MICS. This process requires additional effort and tends to increase ordering costs.

C. RECOMMENDATIONS

1. Change the MICS to provide optimal inventory management by better incorporating cost data and customer service goals. Add demand forecasting and lead time forecasting to the MICS system. Or, replace the MICS with a system that meets these specifications.

If MICS is going to be effective in inventory management the system should be changed to provide the item manager with the ability to optimize stock levels using cost and customer service goals as input data. Forecasts of monthly demand rate and lead time should be included in the inventory management system.

There is indication that MICS will be replaced with a DoD wide medical inventory management system. [Ref. 37] A joint service team was formed in 1990 called the Corporate Information Management Medical Group. The team's function was designated as formulating and implementing the Defense Medical Logistics Standard Support (DMLSS) program with the specific purpose of consolidation, standardization and elimination of duplication among the DoD Services. One aspect of this program is to replace the service-unique medical inventory management systems with a single, integrated medical logistics information system to support material and contracting requirements in

all military medical departments. This information system, due to be released in late 1996, should be designed to incorporate data to meet customer service goals as demonstrated in this thesis, track and incorporate cost data as suggested in this thesis, and provide monthly demand and lead time forecasts at the Medical Treatment Facility level.

2. Continue to expand the Prime Vendor Program.

Because of the benefits associated with higher customer service, the Prime Vendor Program should be expanded. This research indicates that increased ordering costs are a small penalty to pay for the benefits of consistency and accuracy of Prime Vendor . Expansion should be made within the existing contracts and by establishing new contracts. Existing contracts should expand the total number of Distribution and Pricing Agreements (DAPA's), effectively reducing the need for the number of Acquisition Advice Code L procurements which require longer order and ship lead time than Prime Vendor order and ship lead time. New contracts should also be negotiated which establish a Prime Vendor for food and administrative stock items.

3. Conduct a thorough study of the impact of the Prime Vendor Program on cost savings and cost shifting.

No thorough analysis of the impact of the Prime Vendor Program has been conducted by the Navy or DoD. Both cost savings and cost shifting should be analyzed. Thus far the focus has been on inventory reduction. However, storage space issues, personnel requirements, and the impact of changes in ordering and receiving functions have not been thoroughly addressed. Further, analysis of pharmacy operations should be

targeted to determine how best to introduce inventory management techniques in order to achieve reductions in variable inventory costs.

4. Identify and implement methods to increase connectivity between Prime Vendor ordering systems and payment systems.

The full benefit of the Prime Vendor Program will be realized when ordering and bill paying procedures are simplified as a consequence of system interface and connectivity. Objectives of the DMLSS program include eliminating redundancy and achieving integration and effective communication with other standard DoD systems and with the Prime Vendors. If this aspect of DMLSS is successful, some aspects of the aggravated ordering cost evident with the Prime Vendor Program can be expected to be eliminated.

5. Provide training and a vehicle for the Pharmacy to manage inventory.

A result of the Prime Vendor Program is to shift the responsibility of pharmaceutical inventory management to the pharmacy departments with the Medical Treatment Facilities. Inventory management training should be provided to the pharmacies with respect to stockout risks and cost containment. It is recommended that the DMLSS program incorporate the design of a specific, standard inventory management system to be used by the pharmacy for managing stock which will use data relevant to that which applies to the short lead times associated with the Prime Vendor Program.

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